

Pepperdine University

Pepperdine Digital Commons

---

Theses and Dissertations

---

2018

## Librarians leading change: informal learning spaces and the interception of public libraries and STEAM

Cheryl R. Small

Follow this and additional works at: <https://digitalcommons.pepperdine.edu/etd>

---

### Recommended Citation

Small, Cheryl R., "Librarians leading change: informal learning spaces and the interception of public libraries and STEAM" (2018). *Theses and Dissertations*. 1011.  
<https://digitalcommons.pepperdine.edu/etd/1011>

This Dissertation is brought to you for free and open access by Pepperdine Digital Commons. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of Pepperdine Digital Commons. For more information, please contact [josias.bartram@pepperdine.edu](mailto:josias.bartram@pepperdine.edu) , [anna.speth@pepperdine.edu](mailto:anna.speth@pepperdine.edu).

Pepperdine University  
Graduate School of Education and Psychology

LIBRARIANS LEADING CHANGE: INFORMAL LEARNING SPACES AND THE  
INTERCEPTION OF PUBLIC LIBRARIES AND STEAM

A dissertation submitted in partial satisfaction  
of the requirements for the degree of  
Doctor of Education in Organizational Leadership

by

Cheryl R. Small

October, 2018

Farzin Madjidi, Ed.D. – Dissertation Chairperson

This dissertation, written by

Cheryl R. Small

under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Doctoral Committee:

Farzin Madjidi, Ed.D., Chairperson

Lani Simpao Fraizer, Ed.D.

Gabriella Miramontes, Ed.D.

© Copyright by Cheryl R. Small (2018)

All Rights Reserved

## TABLE OF CONTENTS

	Page
LIST OF TABLES .....	vii
LIST OF FIGURES .....	viii
DEDICATION .....	ix
ACKNOWLEDGMENTS .....	x
VITA .....	xi
ABSTRACT .....	xii
Chapter 1. Introduction .....	1
Changing Role of the Public Library .....	2
Repurposing of Collections .....	3
Implications of Automation .....	4
Statement of the Problem .....	5
Purpose Statement .....	6
Research Questions .....	6
Significance of the Study .....	6
Assumptions and Limitations of the Study .....	10
Definition of Terms .....	10
Chapter Summary .....	13
Chapter 2. Literature Review .....	18
Introduction to the Literature Review .....	18
The Public Library .....	24
Background .....	25
What is Informal Learning? .....	30
Informal Learning and the Public Library .....	33
STEAM and the Public Library .....	44
Significance of Makerspaces in Public Libraries .....	47
The Public Interest in Libraries .....	49
The Public Library and STEAM Education .....	50
Chapter Summary .....	63
Chapter 3. Research Design and Methodology .....	68
Introduction .....	68
Restatement of Research Questions .....	68
Nature of the Study .....	69
Methodology .....	71

	Page
Research Design .....	74
Protection of Human Subjects .....	78
Recruitment Process .....	79
Data Collection .....	79
Interview Techniques.....	80
Interview Protocol .....	81
Statement of Personal Bias .....	91
Epoche and Bracketing .....	92
Data Analysis .....	92
Chapter Summary .....	94
Chapter 4. Findings .....	96
Data Collection .....	99
Data Analysis .....	101
Interrater Review Process .....	101
Data Display .....	102
Research Question 1 .....	103
Research Question 2 .....	109
Research Question 3 .....	116
Research Question 4 .....	121
Chapter Summary .....	128
Chapter 5. Conclusions and Recommendations.....	130
Grassroots Development and Making Meaning .....	132
Specialized Skills .....	134
Kits.....	135
Summary of the Study .....	136
Discussion of the Findings.....	140
Implications of the Study.....	147
Recommendation for Future Research .....	150
Final Thoughts .....	151
REFERENCES .....	152
APPENDIX A. IRB Approval Notice .....	180
APPENDIX B. Informed Consent Form .....	181
APPENDIX C. Interview Recruitment E-mail Script.....	184
APPENDIX D. Interview Recruitment Phone Script .....	185
APPENDIX E. Interview Questions Process Form .....	186

	Page
APPENDIX F. Peer Reviewer Form .....	188
APPENDIX G. Permissions for Use of Diagrams.....	191

## LIST OF TABLES

	Page
Table 1. Research Questions and Corresponding Interview Questions .....	83
Table 2. Research Questions and Corresponding Interview Questions with Peer Reviewers .....	86
Table 3. Research Questions and Corresponding Revised Interview Questions .....	89
Table 4. Participants' Statistics .....	99
Table 5. Interrater Review .....	102
Table 6. Summary of Themes for Four Research Questions .....	129
Table 7. Summary of Findings and Related Theories.....	139



## LIST OF FIGURES

	Page
Figure 1. Internet usage 2015.....	36
Figure 2. Millennials are the most likely generation of Americans to use public libraries.. .....	51
Figure 3. Public wants libraries to advance education, improve digital literacy .....	53
Figure 4. Nationwide Reach, STAR Net programs .....	56
Figure 5. Interview question 1: Coding results. ....	104
Figure 6. Interview question 1, follow-up question 1: Coding results.....	107
Figure 7. Interview question 1, follow-up question 2: Coding results.....	108
Figure 8. Interview question 2: Coding results. ....	110
Figure 9. Interview question 3: Coding results. ....	112
Figure 10. Interview question 4: Coding results. ....	114
Figure 11. Interview question 5: Coding results. ....	117
Figure 12. How success is tracked and measured in STEAM programs .....	119
Figure 13. Interview question 7: Coding results. ....	122
Figure 14. Interview question 8: Coding results. ....	124
Figure 15. Interview question 9: Coding results. ....	126

## DEDICATION

This body of work is dedicated to

my Lord and Savior Jesus Christ for his mercy and grace over my life.

To my husband, Leonard Small, who has been a source of constant support,  
to my children, Patrick, Laurie, and Matthew for being kind and thoughtful blessings  
of inspiration through this effort. I love you dearly.

To my parents, Mary and Lorenza, for planting seeds of passion that I continue to discover.

Bless you all!

## ACKNOWLEDGMENTS

A special thank you to those who have daily lifted this dissertation process to God in prayer and have continually given me words of encouragement. Your prayers and support were essential on taking this dissertation from vision to reality.

I am especially appreciative of the leadership of Pepperdine University and specifically the Dissertation Committee, Dr. Farzin, Dr. Frazier, & Dr. Miramontes, for their guiding support, for which I am eternally grateful.

To my editor, Ms. Sharon Williams of Sharon Williams Consulting, for her attention to detail for which I could not do without.

To my husband, Leonard, and children Patrick, Laurie, and Matthew, and friends for their undying support through the process.

To Dr. Elizabeth Watson for her mentorship at the University of West Indies, Barbados, and for speaking the words of possibility as I began the journey.

Thank you to all!

## VITA

### EDUCATION

Pepperdine University, Graduate School of Education and Psychology, Los Angeles, California  
Doctor of Education in Organizational Leadership 2018

Clark Atlanta University, Atlanta, Georgia  
Master of Library Science 1991

Clark Atlanta University, Atlanta, Georgia  
Bachelor of Arts in Spanish 1989

### EMPLOYMENT

Atlanta-Fulton Public Library System, Atlanta, Georgia

Headquarters Library Administrator	2017–present
Branch Library Administrator/Systemwide Youth Services Coordinator	2014–2017
Librarian Manager/Systemwide Youth Services Coordinator	June 2015
Librarian Principal/Manager	2013–2015

University of the West Indies Cave Hill Library, Bridgetown, Barbados

Head of Electronic Resources/Head of Acquisitions	2011–2013
---	-----------

Atlanta-Fulton Public Library System, Atlanta, Georgia

Senior Librarian/Assistant Manager/Department Head	2005–2009
Principal Librarian/Manager	2002–2004
Senior Librarian/Assistant Manager/Department Head	1995–2001
Librarian I/Neighborhood Library	1995–2000
Library Principal Associate: Database Maintenance	1991–1993

### CREDENTIALS

GPRO O & M Training Certification	2015–present
Certified in green operations and maintenance for building construction from conventional to sustainable operations for 10 new facilities and one renovation	

### PROFESSIONAL AFFILIATIONS

American Library Association  
Association of College and Research Libraries  
Black Caucus of the American Library Association

## ABSTRACT

### LIBRARIANS LEADING CHANGE: INFORMAL LEARNING SPACES AND THE INTERCEPTION OF PUBLIC LIBRARIES AND STEAM

Public libraries throughout the United States are increasingly using technological platforms to provide information resources to students across socioeconomic environments. Advances in technology have affected the way in which we learn with the advent of online learning, e-learning and shared learning experiences that have become ever present in schools and libraries. How relevant is the public library in the initiatives that are directly related to the much-needed support of science, technology, engineering, arts, and math (STEAM)? This study explores the public library as a free, public space for informal learning and the democratic ideals of success as it relates to science education, achievement, and national innovation. The purpose of this study was to determine the challenges that the public library experiences in the implementation of STEAM programs, strategies, and practices employed by the public library in managing the implementation, and how the public library measures success in the process. The questions explored are an (a) examination of best practices in developing strategies for implementation and the challenges that public libraries face as they relate to the implementation and development of STEAM programs, (b) the challenges that public libraries face as they relate to the implementation and development of informal learning programs focused on STEAM, (c) how public libraries measure success within informal learning programs related to STEAM, and (d) what lessons have been learned in the development of informal learning spaces focused on STEAM in the public library.

## Chapter 1. Introduction

The disruptive technologies of today are the driving force of the public library worldwide (“Shaping the Future,” n.d.; Vargas, Vanderkast, García, & González, 2015). According to Lee (2007), the dynamic shift from print to digital has had the greatest impact as a result of technology. Author and authority on artificial intelligence, Raymond Kurzweil (1992) foretold what was thought to be the end of books. Although computer technology has increased since then, libraries continue to purchase books, which remain as a Stallworth and a core service alongside new resources and programs. According to *Publisher’s Weekly* and *BookNet Canada*, print book sales were on the increase in 2016 (“BookNet Canada Reports,” 2017; Segura, 2017).

Throughout the last century, libraries have experienced continuous change, driven largely by user demand for fast Internet, access to Wi-Fi in the library and beyond, and resources hitherto never imagined outside the confines of the physical structure. The future of books is a great concern as the digital age continues to affect the circulation of materials and focuses more on electronic resources and how learning takes place in the public library, as noted by the Institute of Museum and Library Services (IMLS, 2017) and others (Cummings, Neatrou & Callaway, 2018; Little, 2011). The IMLS is the primary source of federal support that also provides statistics, demonstrating that citizens support over 16,000 public libraries in the United States that offer a plethora of programs and are primarily focused on digital inclusion and instructional programs related to science, technology, engineering, art and math (STEAM). The thought of the library services having diminishing returns as a result of the technology has been mistaken as growth continues, addressing the needs of 21st-century clientele.

Service in public libraries has exponentially become technological in function as processes and procedures are automated and the constant demand for quicker, smarter, and

virtual access to information increases (ALA Office for Research and Study, 2011). As a result, the public library, a service organization hinged on information at its core, is finding itself in an obligatory stance as it competes with the growth of technology applications. Wiegand (1999) described the field of library information science as an area of study in which the technology to which it is harnessed defines the field.

The use of public libraries has grown beyond imagined numbers, and technology has had an unexpected effect on the role libraries serve. Today's library has been reimagined with the involvement of architects and the provision of space for the arts, meetings, public events, and STEAM programs as it redefines itself as a place of relevance in communities throughout the nation. Reinventing the library, with technology as the catalyst, involves investigating the recent changes related to how learning takes place in the library, how collections are repurposed as a result of technology, and the implications of automated systems.

### **Changing Role of the Public Library**

Much can be said about the future of libraries and the need for instant gratification. The diversification of service modules has moved from what was a written collection of knowledge to one that is mobile and yet connected. The ability and need to reimagine service is evermore clear as the literature expresses the broad range of possibilities in meeting the need of the community (Thompson, 2015). The most practical role of the library is sharing information throughout the lifespan. The learning is centered around organized resources, the preservation of ideas and artifacts, and making the ideas and artifacts accessible, which creates social interaction, bringing people together for a common good or interest. Therefore, the library has always been the place where the sharing of information intersects within a social context within the walls of a physical structure, according to Mattern (2014), who supported the thought of library as a

“platform,” similar to the ideas of Weinberger (2012). The conceptualization was loosely based on a content model resembling Facebook in that the library would provide access to everything including content and the metadata of the content as well as enabling the creation of new products and services from which others could build, thereby integrating everything in the library and creating a net ecosystem.

The changing role of libraries highlights the need for even more services (Mattern, 2014) as opportunity centers where those left behind and disenfranchised can attain a skill or perhaps learn to navigate an increasingly technical world and its complexities. The traditional services are still relevant for many including seniors. The world today requires seniors acclimating to increased technological functions needed for routine business processes (Schwartz, Mosher, Wilson, Lipkus, & Collins, 2002). Many persons also seek assistance with job readiness skills and basic reference information.

### **Repurposing of Collections**

Although libraries struggle with the constant threat of closure and budget cuts (Child & Goulding, 2012), the foot traffic continues. The library is a point of connection, providing vital information for its clients’ survival. The intrinsic need to attain knowledge of some type may not contribute to the circulation of books. Circulation statistics still pose a viable question about the desire for books in the midst of the e-book format. Kurzweil (1992) and Berube (2005) concurred that e-books could conceivably be a threat to physical books with a possibility of obsolescence by the turn of the century, slowly slipping into antiquity and diminishing what has been a reading culture. The provision of electronic resources over the last two decades has been extensive; however, libraries continue to purchase books. Chadwell (2010) in “What’s Next for Collection Management and Manager?” asserted that technology advances to meet demand and



suggested that as the years progress, the use of e-books will become even more robust.

Conversely, the e-book has begun to plateau. The expansion of e-books was rapid. However, this was not the case with music and other digital media that have flooded the public library.

Research found the e-book to be of interest for specific reasons, such as storing a favorite title on a device, using a reference work on a regular basis, and keeping aspirational titles available for reading in the future (Shatzkin, 2011). As public libraries reimagine their spaces, many have engaged in conversations about rethinking and remodeling older structures and the cost of retrofitting their spaces for new technologies (Brown & Long, 2006). Many people do not visit a library solely to read but also to convene in a space. Pritzker Award winning architects Ito and Martin (2013) explored the influences of new media, digital technology, urban environment, and the notion that people go to the library to be a part of the community in the library.

Repurposing the collections also involves what any library experiences when budgetary constraints prevent a rebuilding or renovation but allow for modifications of a few structures to provide spaces that are accommodating and welcoming. Many libraries seek assistance from community entities as well as governing bodies in providing greater accessibility by adding such items as outlets, wiring, and redeveloping layouts of traditional structures for self-service options.

### **Implications of Automation**

Information once perceived to be inaccessible *or* readily available is now part of the world-wide web. Although this seemingly provides a tightening of the gap in digital inclusion as well as the digital divide, other factors preclude the notion. Freeman (2017) and Cohen (1975) discussed other socioeconomic issues and causes in an attempt to address the exclusivity of access and the importance of the libraries' role with the underserved. According to Cotten,

Davisson, Shank, and Ward (2014), although an elevated use of smartphones and digital access is found among children and teens, a divide in levels of access, rationale for use, as well as the skills to navigate the web still exists. Therefore, access does not determine usage or proficiency in use (Stern, Adams, & Elsasser, 2009). The inequalities become ever present in the differences of human assets in online settings. As such, the literature speaks to an underlying digital divide in skills rather than access (Gonzales, 2015). Broadband access, digital literacy, and the library working in concert is a key factor in addressing the society's needs to equalize the justice of possibilities.

The division noted in skills also exists in the realm of achievement as it relates to the dialogue on education. The apparent lack of achievement in the areas of math and science in the United States revealed a heightened concern for technological innovation, and by extension, the economy (Bailey et al., 2016; National Research Council, 2002; "Science & Engineering Indicators," 2018; STEM Education Coalition, 2018). The recent phenomena of science education in public spaces examine the intersection of informal learning, public libraries, and STEAM, creating a rationale that substantiates the public library as a viable organization that supports and implements STEAM initiatives that place value in the ecosystem of learning.

### **Statement of the Problem**

The library experience has vastly changed over the last decade. The usage has increased due in large part to technology, and as a result, usage is varied, multifaceted, and accessible beyond the physical structure. The evolution of service in the public library requires an engagement that is transformative and student-centered (Collins & Somerville, 2008). How can the public library examine its role and contribution of providing educational opportunities related to STEAM programs in an informal setting? How will the public library create value that meets

the enduring and evolving mission of service and the ideals of youth and acquire the leverage needed within organization and community to support a pedagogy of lifelong learning?

### **Purpose Statement**

The purpose of this study was to determine the challenges that the public library experiences in the implementation of STEAM programs, strategies, and practices employed by the public library in managing the implementation, and how the public library measures success in the process. The study also gathers suggestions from public librarians for managing the implementation. Four research questions were created to assist with this process.

### **Research Questions**

The following research questions (RQ) were addressed in this study:

1. What strategies and practices have been implemented in public libraries that focus on informal learning opportunities related to STEAM?
2. What are the challenges that public libraries face as they relate to the implementation and development of informal learning programs focused on STEAM?
3. How do public libraries measure success within informal learning programs related to STEAM?
4. What lessons have been learned in the development of informal learning spaces focused on STEAM in the public library?

### **Significance of the Study**

The timing of this research was of significant value as STEAM programming increases in public libraries (Gangopadhyay, 2017; Rosa, 2017). These efforts also enhance the conversation of informal learning and the need for transformative leadership in the area of data-driven research that supports STEAM learning in the public library. The timing of this study also

aligned with national initiatives such as the STEAM Education Coalition, the National Research Council, and the National Science Board, which were conducting research to improve STEAM education within the context of schools, not public libraries. This phenomenon represents a void in the literature. This study has meaning for addressing the vast importance of STEAM education in public libraries and its contribution to lifelong learning, as well as the logical shift in technology programming that leads to the active participation of the community and the education of its youth. Given the significance of program initiatives related to science education and creative digital literacy that has presented itself in the form of digital labs and makerspaces across the nation in public libraries. There is also a school of thought that access STEM in a broader context to include the arts primarily due to the creative elements of science that is centered around the creative elements of innovation such as making of exhibits, demonstrations and models that provide a physical replication of investigating and the art based requirements of STEM projects and programs. According to the Maker Spaces and making is significant to the paper as a key component of STEAM initiatives that introduce marketable and strategic skills attainment for youth and future career pathways. This paper examines the opportunities for informal learning in a public library setting that can stimulate the interest of children in the area of computer science in concert with the educational platforms on science education known as STEAM. This research sought to show the value of informal learning initiatives in the form of science, technology, engineering, art, and math education in public libraries.

**Significance for patrons.** According to Wiegand (1999), the 20th-century American, the library was one the nation's most understudied yet ubiquitous institutions. The American library possesses a rich history of service to millions of people across generations. However, research on the public library and the community it serves is not adequately represented in the literature as an

educational, mission-driven organization (Gross, 2013). This affects the role of the present-day library and the future of the public library. One area for further theoretical research is the need and desire of the general public for STEAM programs in a public setting. The evidence of such need is embedded in the changing roles of public libraries.

Andrew Carnegie (1835–1919) was one of the formidable philanthropists of his era. Carnegie was an immigrant who, as a young man, amassed wealth through various business investments in steel production and iron works, railroads, and oil wells. Carnegie, who worked long hours in his youth, had no access to formal education; however, a retired merchant, Colonel Anderson—to whom Carnegie gave much credit for his success—loaned books to Carnegie and his contemporaries from Anderson’s small, private library. The actions of Colonel Anderson would spark the development of over 2,509 libraries throughout the world (“Andrew Carnegie’s Story,” 2015). Carnegie’s vision was attributed to his desire to give all Americans access to books and to provide information for immigrants on the culture of their new home (Whyte, n.d.).

Andrew Carnegie’s contribution to the development of public libraries and the transformation of access to information is very much akin to the transformation that is eminent today. The public library has an opportunity to redefine itself, as a result of technological advances and the intersection of science education services in public libraries. Advances in technology and the augmentation of access has changed the relationship with its patrons who now can have access anytime and anywhere with services such as e-books, electronic resources, and self-directed use of accounts.

New technologies have surfaced in public libraries, schools, and the world we live in, transforming the ways we live, work, communicate, and learn. The nature of digital literacy is contingent upon the context of informal learning settings, such as public libraries, as a real-

world, authentic measure of filling the gaps in digital readiness for the general public, a means for introducing access, and in particular, providing STEAM programming. Informal learning in the public library provides an opportunity for today's youth to conceivably grasp some understanding of their future involvement in career paths that involve science and hands on opportunities that involve innovation.

**Significance for public libraries and schools.** The significance of this study as it relates to the public library is in the form of grounded research on a public organization that serves everyone. The prevalence of public libraries as a community entity, according to Freeman (2017), gives credence to the increased levels of support across the nation during the last decade. The American Library Association's (ALA) public library survey demonstrated the level of use and for what reasons ("Digital Inclusion Survey," 2013). This study adds value to the mission of the ALA and assists librarians in their efforts to provide programming that meets the needs of the community.

The significance for schools as educational partners with public libraries is to address the national initiative to improve overall performance of students in science, technology, engineering, and math. The goals are to also prepare students for career paths in the sciences by integrating science education programs in informal settings with formal school learning. The concepts of informal learning and digital literacy are both contingents of the Internet. The literature speaks to how the Internet has had a profound effect on public libraries (Kinney, 2010) as the mechanisms through which services are delivered. As reported by the National Telecommunications and Infrastructure Administration (NTIA; 1999), the Internet was introduced in public libraries in the late 1990s by the NTIA of the United States Department of Commerce and its third report addressing the digital divide in a document titled "Falling

Through the Net II: New Data on the Digital Divide” (McConnaughey & Lader, 1998). The concept of universal service was introduced during 1995–2000, as detailed in NTIA’s report, which extended the service from telephone to the Internet. This idea also identified some disparities in access and service across demographic lines that are lessened today but not obliterated.

Much of the demand has been reported via surveys that document the desire for programs in the areas of digital inclusion and STEAM. Despite the far-reaching results shown by the ALA and IMLS, no dominant research has focused on informal learning within the walls of public libraries. Public libraries have been targeted as untapped spaces for STEAM programs by many outside of the institution. Many organizations partner with and support such programming, but support of a theoretical framework of learning by the libraries and librarian themselves is needed to create a relevance that is meaningful and justifiable within the field of library science.

### **Assumptions and Limitations of the Study**

This study assumes that IPAC is the only organization that is a definitive resource providing information for public libraries in the United States. Although some data are available as a result of the survey implemented by ALA, the Institute for Museum, and IMLS and gathered by Information and Policy Access Center (IPAC), every state was not represented in the study.

### **Definition of Terms**

The following definitions were gleaned and simplified from several research resources that have contributed to the subject matter and will appear repeatedly throughout the study.

- Digital divide—Digital divide, as it relates to public libraries, addresses the inequalities in web access for the general public and by extension, human capital.

Gunkel (2003) described the term as the gap separating those individuals who have access to new forms of information technology from those who do not.

- Digital inclusion—The shift in technology, as it relates to public libraries, includes an increased need for training of the general public in the use and functionality of technology and an increased, positive effect on the everyday lives of patrons. The Institute of Museum and Library Science (“Toward Equality of Access,” 2004) defined digital inclusion as the ability of individuals and groups to use technologies to access information and communication systems.
- Informal learning—Learning that is beyond the classroom and the question of whether informal learning elevates and provides well-being is experiencing a resurgence of interest. These emerging perspectives on informal learning are directly related to STEAM initiatives in public libraries as pathways to interest in science. The lifelong process by which every individual acquires and accumulates knowledge, skills, attitudes, and insights includes daily experiences and exposure to the environment at home, work, and play; the examples and attitudes of families and friends; travel, reading newspapers, and books; and listening to the radio and viewing films or television. Generally, informal education is unorganized, unsystematic, and even unintentional at times and accounts for much of any person’s total lifetime learning—including persons with formal education (Coombs & Ahmed, 1974).
- Informal learning spaces—The public library is one example of an informal learning space that provides opportunities for self-directed, lifelong learning. The term was defined by Harrop and Turpin (2013) as non-discipline-specific spaces frequented by



both staff and students for self-directed learning activities and can be within or outside library spaces

- STEAM— An acronym developed as a result of educators observing a need to inject creativity in the teaching of STEAM—science, technology, engineering, arts, and math. Proficiency at STEAM has been a goal of educators for the last decade as a need to increase performance in math and science across the nation.
- STEM—As defined by Hom (2014), STEM is a curriculum based on the idea of educating students on four specific disciplines—science, technology, engineering, and mathematics. The acronym was previously SMET and was coined STEM by Dr. Judith Ramaley (as cited in Hom, 2014), director of education and human resource directorate for the National Science Foundation from 2001–04. Later, STEM was developed to demonstrate a connection between each discipline and not one being superior to the others (Sanders, 2009).
- STEAM education—Many educational institutions and organization have placed an emphasis on STEAM. As a result, curricula have been revised to meet the needs of this national initiative. The phrase *STEAM education* is an interdisciplinary approach to learning in which rigorous academic concepts are coupled with real-world lessons (Tsupros, Kohler, & Hallinen, 2009). STEAM education includes teaching and learning apply science, technology, engineering, and mathematics through educational activities to make connections between school, community, work, and the global enterprise. The concepts range across all grade levels from primary to post-doctorate (Gonzalez & Kuenzi, 2012), enabling the development of STEAM literacy and choices for work, study, and career (Beatty, 2011).

## Chapter Summary

This chapter explored the changing role of libraries and the implications of technology to its service model, the patrons that are served and future programs needed that address the changing tides of the society. As technology intensifies the services offered are beyond the existing walls and therefore thought must be given to the structure, the use of space, the acquisition of materials and equipment (LaConte & Dusenbery, 2016; Omdal et al., 2006). Although many changes to the service model have been made, a vast amount of resources continue to support public libraries' commitment to lifelong learning for the communities they serve. The library collections are relevant and responsive and provide educational support for school enrichment, the services offered are enhanced as a result of technology, and the spaces are utilized to best support the communities served. The advent of technology has had a considerable effect on the level of enrichment librarians are able to provide to all library users.

Clark (2015) asserted that the public library continues to evolve as technology advances. The survey conducted by ALA, IMLS, and IPAC has shown the progression of digital inclusion in the overall operations of the public library. The literature conveys the importance of meeting the population's needs for access, application, and programs to further the education of 21st-century patrons. These informal opportunities for learning the STEAM disciplines provide access for students who may not otherwise have this kind of exposure. The digital inclusion programs offer a pathway for all to enhance skills and gain access to programs that may ignite interest in a career. According to the Aspen Institute, the libraries' role in society is becoming transformative by virtue of the innovative culture created with programs such as STEAM that provide new forms of participation (Garmer, 2014). These programs lead to fulfillment of the democratic ideals of success.

Wilbur Cohen wrote that “learning is a continuous, permanent, lifelong pursuit. It is a process which commences with birth and only terminates at death and is then carried on by others in a never-ending continuum” (1975, p. 83). According to ALA, lifelong learning was established as a core value of librarianship and being central to the “enhancement of a learning society” (Elmborg, 2016, p. 533). The library is that one location where the new technology and the traditional forms of information gathering mesh. Learning and literacy in the public library has been one of situated learning, in that the adult is engaged in learning and self-initiating skills needed in the midst of working a job or caring for a family. Therefore, lifelong learning is what the adult desires, and it is driven by the user. This tendency does not transcend cultures but only derives from the social context in which it is shared across cultures and is dependent on the social context in which it is embedded.

Literacy is also considered to be intergenerational, with one generation influencing the other, and has been seen as a pathway out of poverty (Thompson, 2012). Another significant finding is that the need to improve literacy is just as important for children as for adults, given the longevity of today's population. Robinson et al. (2015) also explained the effects of digital literacy and the inequalities that senior citizens face as much or more than those of working age. This insight provides further justification for informal learning in a public setting that might provide even more social and economic stability, which is important for today's lifestyles of social interaction and educational modes of learning via computers.

The characteristics of STEAM and the support the both formal and informal learning of science have strong possibilities for an even broader reach. Our nation is in need of reform in education; however, in the midst of this discussion, the educator's role as innovator is in need of community involvement and funding (STEM Education Coalition, 2018). The use of out-of-

school settings such as the public libraries as a possibility of broadening STEAM initiatives and programs for future generation is one to be considered. Much has been said about schools not performing according to standards (Drew, 2011; National Academies of Sciences, Engineering, and Medicine, 2016); however, the National Research Council, Board of Science Education, and The Center for Education, as well as the Board for Testing and Assessment have supported research and numerous workshops and programs that can support STEAM disciplines effectively.

The prospect of the public library, the one remaining independent civic organization, having an influence on the innovative research of informal learning is very much congruent with the overarching mission of lifelong learning and access. Bell, Lewenstein, Shouse, and Feder (2009) identified a significant number of studies that support the role of the public library as an informal learning space or out-of-school experience that can provide opportunities for STEAM achievement. Progress has been made in the growth of informal learning opportunities over the last 200 years in the United States and specifically, in the presence of science as a social construct in the everyday lives of people (Bell et al., 2009).

The 1993 report on the Federal Coordinating Council of Science, Engineering, and Technology confirmed the federal government's expenditures of over \$67 million on the public understanding of science (cited in Feder, Shouse, Lewenstein, & Bell, 2012). The support of national foundations and nonprofit research is evident in the literature review; however, central planning for future initiatives are emerging ("Shaping the Future of digital economy and society," n.d.). Today, most STEAM programs in public libraries are facilitated by professionals and experts in various science fields. Funding is customarily provided through grants from foundations and corporate entities.

Finally, Chapter 1 explores the state of public libraries and the support for an increased interest in STEAM programs (Bell et al., 2009; IMLS, 2017; “Libraries Support Digital Readiness,” 2014). The programs have recognized not only the need for STEAM learning as an educational support to schools but also as a catalyst for the introduction to new technologies in the realm of the digital divide (Cohron, 2015), and the national effort to enhance performance as well as career paths in the sciences (Dusenbery, 2014; “Fact Sheet,” 2016; Rainie & Anderson, 2017). The other aspects for consideration is the history of the public library as a lifelong learning entity. The public library has been a free public learning space that has sustained itself throughout the years for the underserved, providing programs to supplement and assist parents and students with materials that support the school curriculum and meeting the needs of the community at large (Garmer, 2014).

The relevance of STEAM programs for society has brought an increased emphasis on children and achievement in the area of science, math and the make trend. The public library has historically linked itself to education dating back to the 18th century and have symbiotically existed hand in hand throughout the changing of times. In the last decade, technological advances have created an interest and platform for the sciences and creativity that have begun to address a greater need for innovation and economic stability for future generations (Subramaniam, Ahn, Fleischmann, & Druin, 2012). In recent years, conversations have included architects and space planners to ensure the creation of successful informal learning spaces that support science, technology, engineering, arts and mathematics learning. The library as a place for a deeper engaging opportunity to explore and test curiosity through a creative blend of science and art that introduces concepts of “making” that are grounded in engineering and the construction of things in library space sometimes called maker spaces. This study sought to offer

best practices for the implementation of STEAM programs as viable informal learning spaces for future generations in public libraries. This research also sought to add value to STEAM efforts in public libraries and contribute to the next generation of STEAM learning. These initiatives also create further relevance for the public library as an informal learning setting that specifically addresses the credibility of this neutral space and its commitment to supporting the community, learning, and national advancement.

## **Chapter 2. Literature Review**

### **Introduction to the Literature Review**

This chapter reviews literature relevant to studying how individual frames of reference influence informal learning in public libraries, and the history and plausibility of STEAM programs within the public library as a means for securing the democratic ideals of providing access, social and economic possibilities for 21st-century youth. In the public library, the term *digital literacy*, as defined by Visser (2012), means “having the ability to use information and communication technologies to evaluate, create, and communicate information” (para. 2) with a conceptual understanding of safety, license, permission, and ethics in the appropriate use of information that requires both cognitive and technical skill (Erickson, Meyers, & Small, 2013). The inception of computers in the public library during the early 1990’s represented a massive undertaking of providing instruction for the employees and the general public on how to use the hardware and software. Both have inevitably changed and advanced in difficulty as technology gradually become more complex over the last century. In the midst of this evolution is an undeniable need for instruction from one year to the next. In addition to the necessity of developing skill sets, new divides need to be addressed in the public library and how these needs should be met in equal measure to maintain access as a necessary means of closing the digital divide (Carlson & Goss, 2016; Erickson et al., 2013; Swan, Grimes, & Owens, 2013).

The library continues to evolve on the level of service offered and programming offered to a digitally savvy clientele. Mattern (2014) described the arrangement as an informational and social infrastructure meeting at a physical infrastructure to support the need. Weinberger (2012) contended that the library should be thought of as an “open platform” with open collections and the exposure of metadata. This model would create “free innovation”—another model introduced

by Eric von Hippel (2017)—and creativity building, on the notion of providing products and services and moving away from the provision of resources.

The way in which the service is rendered today requires flexibility and agility of a workforce that is not prepared or lacks the skills to negotiate, perceive, and plan for the needs of tomorrow's library. Elmborg (2016) presented the argument that if the public library indeed seeks to establish a pedagogical model for lifelong learning in its attainment of professional learning and the development of formal information learning within the organization, a firm commitment to the terms *core value* and *lifelong learning* is needed, as determined in the mission of the American Library Association. Anderton (2012) questioned that if indeed the commitment exists, then why are only meager means available for addressing funding and increasing new literacies in public libraries? Elmborg (2016) concluded that until these areas are confronted, the public library is strictly a support entity for educational institutions.

According to the Institute of Library and Museum Services (IMLS, 2017), over 16,000 public libraries are present in the United States; programs are offered in the areas of technology, digital inclusion, and instructional programs to assist in the application of such technologies. The public library has become a learning center, a learning hub, a tech center with descriptors that provide valuable resources and programs in the area of digital inclusion—generally and specifically in STEAM-related subjects (Baek, 2013; Bell et al., 2009; Dusenbery, 2014). In today's library, the average person can access most choices electronically in the form of e-books and databases. Technology has had an effect on the use of books and inevitably allows patrons to interact with the library beyond its brick and mortar. In the same vain, young people born in the last decade have an orientation to technology that is second nature to their ability to find information. In the midst of this phenomena, a segment of the population has limited or



inconsistent access to technology. Code.org, a national organization, has begun an initiative to provide rigorous curricula in schools, educate teachers, and provide initiatives that focus on improving access to computer science (“Code.org: Anybody Can Learn,” 2017).

The National Academy of Sciences (2007), as well as the National Academy of Engineering (2008), is comprised of many leading research initiatives. They embrace the understanding of science and its influence, as both organizations assert that global issues such as climate change, threats to human health, and access to clean water are the major challenges facing society today and are rooted in the fundamentals of STEAM. The issue is the need for persons with the prerequisite skills to address such future challenges. Current and future students who are diverse and skilled in STEAM career pathways must be prepared, which is critical to the needed innovation and ambitious rigor in a STEM-capable workforce (“Revisiting the STEM Workforce,” 2015). In 2009, President Obama ignited much discussion on “the race to educate our kids” (Rottenborn, 2009, p. 11), in order to sustain the United States as the leader in research and technology. The initiative began with ambitious goals to bring forth the need for achievements in math and science, and by extension, transform the educational systems to prepare today’s youth for tomorrow's workforce.

The dialogue on education is an accurate result of concerns about the apparent lack of student achievement in the areas of math and science, as well as the need for the United States to project the vitality of an economy that is hinged upon technological innovation. When the U.S. Department of Education examined the presence of science and math efforts in research as well as the graduation rates of students in STEAM-related fields, it presented an alarming call, as the prospective jobs for a student in 2020 involve career paths that are currently unnamed but dependent upon the evolving technological advances. Anderton (2012) described the

phenomenon as a pedagogical zeitgeist that the public library supports by providing and helping schools and parents with resources and programs that contribute to integrating these initiatives into the community as a whole. This statement reflected one of the enduring missions of public libraries—to enhance learning and provide access to information for all.

Informal learning in public libraries has become an attractive commodity in general, and with the recent proliferation of STEAM learning in the form of programs in public libraries, much is being written about this phenomenon. Informal learning has fundamentally substantiated the public library and its underlying mission of lifelong learning that began with philanthropist Andrew Carnegie. Carnegie, a Scottish American philanthropist, built 2,509 libraries between 1883 and 1929: 1,689 libraries in the United States, 660 in the United Kingdom, 125 in Canada and others in Russia, South Africa, New Zealand, Serbia, Belgium, France, the Caribbean, Mauritius, Malaysia, and Fiji (Larsen, 2017).

Carnegie's “free-to-the -people libraries,” as coined by Lowry (2003, p. 1) are one of the most significant cultural exchanges of humility. Lowry described libraries as a gift that has shaped the minds and lives of millions. This adage relates to some of the most powerful learning effects in the public domain. According to Allen et al. (2007), an informal learning environment is learner-centered, specifically because the agenda is agreed upon by the participants. For example, they include the involvement of peers, parents, and facilitators without any perceived limitations on the learning potential. This interaction allows for spontaneity that encourages self-seeking of goals and motivates further interest.

The new technologies that are utilized in public libraries, schools, and the world in which we live have transformed how we live, work, communicate, and learn. The nature of digital literacy is contingent upon the context of informal learning settings, such as public libraries, as

(a) a real-world, authentic measure for filling the gaps in the digital readiness of the general public; and (b) a means for providing access, and in particular, STEAM programming. Informal learning in the public library provides an opportunity for 21st-century students to take control, creating and mapping their future involvement in career paths that involve science and innovation.

This chapter examines the literature regarding the intersection of informal learning and public libraries. The content also explores how libraries, as informal spaces in cooperation with the schools and businesses, will prepare the public through the use of alternative educational platforms for achievement, economic stability, and workforce readiness within the domain of its fundamental mission to provide access and engender the tenets of lifelong learning. Resources used for this research include university, public, and private library resources available from EBSCO, ProQuest, and Digital Dissertations, via access through Pepperdine University's library website and home page. The nomenclature in this search criteria includes learning, non-formal learning, informal learning, incidental learning, experiential learning, public libraries, science education, digital literacy, digital divide, and science, technology, engineering, arts, and math, commonly identified as STEAM.

The continuous intersection of technology and public libraries is a topic that requires further exploration. The future existence of a structure called a library and the defining of the public library as place not only for books but a place that ignites ideas for those who would not otherwise have access, exposure, and experiential learning options presents a dilemma. The provision of space and constructivism in a public place allows for creative thinking, collaboration, problem solving, and critical thinking in an ever-changing society that is greatly influenced by technology. These realities and dilemmas require a critical look at best practices

for future public libraries and the implementation of STEAM programming. This research explored some uncharted territory related to the role of the public library as a viable place for informal learning opportunities that produce sustainable results.

This research synthesizes the concepts of learning and establishes the public library as an informal environment for learning the sciences. In today's library, increased automation is making the library a technologically rich environment with collaborative spaces for learning. Perhaps these efforts are also possible with the over 16,000 public libraries offering STEAM-related programs that involve science education and learning. The opportunity exists to influence the trajectory of students of underserved populations who lack access and mentoring for building a future in yet-to-be named professions in the sciences.

This dissertation addresses the fundamental question regarding science learning in an informal setting and the best practices needed for implementation and maintenance of such programs for future librarians and the youth served in the near future. A large body of information on informal learning is available; however, when linked to the public library, that body of information is limited in scope. The intent is to contribute to the breadth of research on the topic of informal learning in public libraries, address the changing roles of libraries, as well as the future of public libraries as STEAM learning environments. These themes will hopefully influence the reform of schools, policy making structures, funding, and the recognition of the value of public libraries as informal learning spaces.

The Digital Inclusion Survey (2013) provided comprehensive data that supports evidence of the public libraries' commitment to foster access and inclusion in advanced technological initiatives throughout the nation. The public library ensures opportunities for success in building technological competencies through programs that support digital readiness (Gerding, 2011,

IMLS, 2017). In an effort to engender the endearing mission of the American Library Association, the majority of program offerings involve the guidance of the participants. The program renderings are guided by the request of the individual or the community in concert with the education entities in the community.

### **The Public Library**

Within the context of the research, some delineation between the public library and other libraries is needed, including the public library's role and stance in comparison to all other types of libraries. The United States has an estimated 119,487 libraries, which vary in type ("Number of Libraries in the United States," 2006). The data that support the numbers are derived from three organizations that support libraries through government funding. The three organizations are IMLS, The National Center for Education Statistics, and The American Library Directory.

The IMLS is the primary source of federal support for libraries and museums in the United States. The IMLS assists libraries and museums with encouragement in the development of lifelong learning initiatives, advances in innovations such as STEAM, and support for cultural and civic engagement. The support extends to all facets of libraries, historical societies, planetariums, botanic gardens, and zoos. The IMLS undergirds the efforts of libraries and museums in the form of research, such as the public library survey. Such reports support the efforts of the local library in discerning trends that appear throughout the nation, as well as the recognition of needs of museums and libraries and the services offered. The research also recognizes statistics, reports, and the effectiveness of the services offered as it assists with plans that will improve the delivery of services, as well as identifying best practices for program implementation ("Libraries Support Digital Readiness," 2014; IMLS, 2017).

The National Center for Education Statistics (NCES) collects and analyzes data for the purposes of measuring performance in education in the United States. The NCES is the predominant funding entity and relies on the data collected to continue its efforts to support education. NCES's responsibility is a congressional mandate to collect, analyze, and report on the condition of education in America. The public library is an educational support entity ("Education and Continuous Learning," 2007), that is a free organization open to everyone regardless of educational attainment, age, or socioeconomic status. The NCES supports public, academic, school, and state libraries through a library statistics program. The NCES conducts the Academic Library Survey as a part of an integrated, postsecondary data system (IPEDS) before 2017, the Public Library Survey was conducted by NCES; however, currently it is conducted by IMLS and houses retrospective surveys previously done by NCES.

The American Library Directory maintains a list of personnel and a plethora of information on its organizations, special collections, and consortium libraries, as well as libraries equipped for people with differing abilities and in-service educational programs. All three organizations collect and provide essential data for public librarians, with IMLS being the mandated preponderate of funding (Rosa, 2017).

## **Background**

The Internet was introduced in the public libraries in the late 1990s by the NTIA of the United States Department of Commerce (USDC). The concept of universal service was introduced during 1995–2000, which extended the service from telephone to the Internet, as highlighted in the report entitled "Falling Through the Net II" (McConnaughey & Lader, 1998).

This idea also presented some disparity in access and services across demographic lines that speak to the digital inequalities that prevail. The question of access remains today, as the

concept of digital divide has shifted to socioeconomic limitations such as access to broadband, the skill set of users, and literacy—the ability to read and comprehend (Cohron, 2015; Kinney, 2010; Robinson et al., 2015).

According to “State of the Urban/Rural Digital Divide” (Swan et al., 2013), 75% of the American population has access to and use of the Internet; however, a significant discrepancy remains between urban and rural populations despite the increased accessibility and adoption of devices such as smartphones. Similarly, Swan et al. (2013) stated that although the public library provides access to segments of the population, some would-be users have challenges based on location, such as in rural areas. In spite of the local, fiscal, and technological disadvantages rural users face, the public library in rural America serves a vital role for persons who otherwise are difficult to engage because of distance from broadband access. Other areas of concern when seeking to assist rural communities include the level of educational attainment, the lack of skill in the use of technology, and literacy skills, which is less uncommon for the urban dweller (Hoffman, 1998).

The gap existing between those who have Internet access and those who do not seems to be closing; however, for some communities, a slower process has presented itself as a delayed effect, realized from the existing economic, social, and historical inequalities related to race, gender, and income that predicated the divide (NTIA, 2017; Robinson et al., 2015). The public library initially was conceptualized as the equalizer (“Declaration for the Right to Libraries,” 2013) where anyone could come and obtain access as a result of the infusion of technology.

Vice President Al Gore, the most noted viable advocate for the Internet, introduced what was initially call the “The National Data Highway.” The advances in a combination of technologies that involved advances in cellular networks, fiber optics, and cable presented new

ways to communicate (Ives, 1993). In 1994, President William “Bill” Clinton declared in the State of the Union address that the Internet would “connect school, the hospitalized, and public library to what was called the super highway by 2000” (McClure, Bertot, & Zweizig, 1994, p. 1).

The public library was thought to be the perfect, free entity to meet the needs of the underserved. In the 2016 State of the Union address, President Barack Obama spoke of “empowering our youth for 21st-century careers” through a new emphasis on computer science and coding called “computer science for all” that brought forth attention to a dire need for students’ mastery of science education and STEM-related initiatives (“Fact Sheet,” 2016, para. 3). This seemingly new push for science education was not a first effort, but had been recognized by past presidents Dwight E. Eisenhower and John F. Kennedy during the Sputnik era (Powell, 2007), by NASA, and in the challenge America felt as a result of the launching of the Russian satellite in 1957 (“A Look at the History,” 2016). In the early 1990s, with inception of the personal computer in public libraries, U.S. educators found it necessary to increase standards and curricula related to STEM.

According to Nishi (2011), libraries are recognized as providing an opportunity for all Americans. The library was the one premier place where all people, regardless of age, ethnicity, income, or level of education, could have free access to the Internet, and by extension, access to the possibility of success. As libraries continue to experience the fast rate of changes in technology, the disruption of what has been known as a standard is likely to increase with a steady climb in the next few decades of the 21st century, as predicted by library strategist Levien (2011). These disruptive technologies assessed by Levien (2011) have gradually eradicated, in just a few years, an existing system that lasted for centuries, with improvements along the way.



Levien (2011) asserted the possibility of thriving amid continuing economic and funding declines with a hard and fast analysis of service structures. The article, “Future of Libraries,” Kurzweil, 1992) addressed the fundamental needs of a population’s reliance on the public library as a free commodity. However, this free place that assures access for the economically disenfranchised; a risk is posed if the library doesn’t stay abreast of the demands of the public. As such, many libraries have difficulty maintaining Internet services due to funding and infrastructure, according to the Wisconsin Department of Public Instruction (Ward & Hart, 2008).

While informal learning is the driving force for this research and its relationship to public libraries, the underlying topics in libraries according to an article by ALA, (“The Digital Inclusion Survey,” 2013) includes digital inclusion and digital literacy (“Public Libraries Lead the Way,” 2014). These issues are a result of evolving technological advances and the inequalities this movement has uncovered. These issues are the foundation from which STEAM programming has intercepted the programming initiatives of the public library and other informal learning hubs throughout the United States.

“The Digital Inclusion Survey” (2013) conducted by the American Library Association was the first of its kind, as no other national survey measured the extent to which the public library had integrated its service to meet and support the human capital with programs that could affect the economic growth and development of the citizenry. The survey measured programs that were educational, entrepreneurial, offered job readiness skills, and fostered personal enrichment. According to the ALA (2017), “the study also begins to map new programs and technology resources that range from STEM (science, technology, engineering, and math) maker programming to 3-D printing to hackathons” (para. 1–2).

As a library positions itself to help all in the community, a few statistics must be considered:

- essentially all (98%) libraries offer free public, Wi-Fi, up from (89%) in 2012;
- nearly 98% of libraries offer technology, literacy, and job readiness training;
- one-third of libraries provide literacy, GED, STEAM, and afterschool programs;
- an estimated 95% of libraries support “out of school” with summer reading programs;
- 60% of libraries host social events that support literacy through book club discussions;
- 98% provide assistance to patrons through government assistance programs and their websites; and
- every library supports patrons seeking employment with workshops and online help (“Digital Inclusion Survey,” 2013).

The Digital Inclusion Survey (DIS) provided the first look at emerging trends in the area of STEAM. The American Library Association reported over 3,000 public libraries supported programs involving makerspaces, 3-D printings, application development, and coding. The ideas of creating is becoming a new digital competency as libraries build and expand their collections of programs, expertise, and space to encompass the needs of the community yearning for technology and its possibilities. The Obama Administration recognized the country’s need to enhance science education that would help maintain the innovative stronghold that once was prevalent in the history of the United States. However, in recent comparisons to other nations, the U.S. has lagged in educational performance and maintaining cutting-edge curricula preparing children for 21st-century career paths in the sciences. The literature on the inequalities of the digital divide is relevant to the topic, as Robinson et al. (2015) wrote of the digital differences

with regard to access, usage, skills, and self- perceptions, as well as future lines of related research.

### **What is Informal Learning?**

The major influential theories on the learning process and the acquisition of knowledge include behaviorist theories, cognitive psychology, constructivism, social constructivism, experiential learning, situated learning theory, and community of practice. The empirical process of studying the phenomena of learning began at the turn of the 20th century. This paper addresses learning as a pervasive change in behavior born out of an experience that helps to make sense of future problems. A few major theories have influenced the concept of informal learning and its origins that occur in the theoretical framework of constructivism, cognitive theory, social learning theory, and the humanistic perspectives of learning. Malcolm Knowles coined the term *informal learning* in 1950 (as cited in Knowles, 1950), developing the notion that all adult education is informal.

However, at an even earlier stage, John Dewey conceptualized the notion of informal learning (“Recognition,” 2010). The Organization for Economic Co-operation and Development (OECD) evaluated the returns of schooling and vocational and occupational training in OECD countries, of which the U.S. and UK have a preponderance of statistics. According to Cohn and Addison (2006), the role of human capital on economic growth and development is of great importance. OECD’s evaluation and the discussion on the legitimacy of informal post-school training became relevant.

Due to the structural changes in the world, the way in which information is garnered also changes and affects the ways people learn. Changes in content and methodologies have been heavily influenced by technology, and the means by which information is accessed and collected

in larger quantities allowed for a larger grasp of information by extension learning, now considered a modern learning method. Informal learning can also be categorized as incidental learning, which is not typically structured nor classroom-based. Informal learning can be intentionally encouraged or take place in a space that is not necessarily conducive to learning (Groff, 2013; Holton & Swanson, 2010; Riel, 1994).

In comparison, incidental learning exists exponentially and can take place unconsciously (Garrick, 1998; Marsick & Watkins, 2001). The notion of the limited focus of traditional modes of learning and outcomes are at odds with how learning takes place outside of the realms of school. According to Feder et al. (2012), the theoretical discussion of learning has been focused on experiences with school, but the pursuit of many social activities such as visiting a museum or gaming experiences can potentially lead to an increased interest in the formation of career paths. The National Research Council (2011) asserted that experiences garnered in early childhood are valuable in providing the underpinnings of learning that are specific to a profession.

In the context of learning, informal learning is any learning that is neither formal nor non-formal learning. Non-formal learning, according to the OECD ("Recognition," 2010), is learning that takes place in a setting that is not an official classroom mandated by an educational system. Informal learning can be thought of as real learning or do-it-yourself learning without controls over the experience (Lee, 2009). Informal learning is an independent process that is not imposed by someone else. Informal opportunities are fluid and can be structures but without the constructs of a curriculum or any other requirement associated with formal education parameters. Conversely, informal learning can take place anywhere without an age limitation and only requires the desire and use of the senses. A familiar element of formal education is the implementation of testing with the prevalence of results that can inflict pressure on the

participant. The theory and practice of the phenomena of informal learning have resurfaced in the writings of researchers such as Coffield (2000), who asserted that informal learning should not have a lesser value and a prerequisite to formal learning processes. Coffield (2000) sees informal learning as an inherent element in the learning paradigm and germane to seeking employment and skills needed.

The literature also speaks of a collaborative innovator who asserted that informal learning is a step into a new dimension of education. Leadbeater (2000) wrote of moving away from viewing education as a rite of passage involving the acquisition of enough knowledge and qualifications to acquire an adult station in life. The point of education should not be to inculcate a body of knowledge but to develop the basic capabilities of literacy and numeracy, as well as the capability to act responsibly towards others, take initiative, and to work creatively and collaboratively. The most important capability—and the one that traditional education is worst at creating—is the ability and yearning to carry on learning. Leadbeater (2000) asserted that too much schooling kills off a desire to learn. Schools and universities should become more like hubs of learning, within the community and capable of extending into the community. More learning needs to happen at home, in offices, and kitchens—in the contexts where knowledge is deployed to solve problems and add value to people's lives.

The library is a lifelong learning organization of which many have written. One example is Bekerman, Burbules, and Silberman-Keller (2006), who worked with a group of international researchers who support the notion of a resource book that guides academia and professional and lay readers to futuristic thinking on learning practices. The majority of policymakers influencing education perhaps regard informal learning practices to be supplemental, marginal, and recreational; little recognition has been given to informal education until recently. The pursuit of

lifelong learning as described by Cohen (1975) and Elmborg (2016) should be a core value for public libraries and one that substantiates the profession and its service.

### **Informal Learning and the Public Library**

The public library has traditionally engendered learning as a provider of information; however, with the pervasiveness of access beyond the book and even the physical structure, libraries also promote learning through instructional programs. These programs are also examples of informal learning that Gilton (2012) delineated as information literacy instruction (ILI). Combined with traditional library services, ILI indeed promotes learning. Another example was reported by (Lemke, Lecusay, Cole, & Michalchik, 2012) as informal learning in media-rich environments such as libraries. Informal learning encompasses a broad category of activities that involve face-to-face experiences that are not formal in content and may include voluntary participation in science-gearred programs such as STEAM initiatives that are prevalent across the United States, according to the 2016 American Library Association survey. Participation in all STEAM-related programs are voluntary and are developed for children to engage with each other and explore for the sake of learning. STEAM programs require communication skills, literacy skills, critical thinking, problem-solving, self-management, and teamwork, all of which are key to having discipline-specific knowledge and capability (Koehler, 2015).

Nielsen (2014) took the stance in his work, *Public Libraries and Lifelong Learning*, of understanding libraries as part of the phenomena of lifelong learning in this age of information literacy, which is an essential part of today's ease of access to information in the public library. Establishing the concept of learning throughout life or periodically is in agreement with the mission of the American Library Association's "Education and Continuous Learning" (2007).

The efforts to provide access and information that are not restricted to educational institutions supports self-directed learning and improves the overall well-being of the citizenry economically, politically, and socially.

Feder et al. (2012) in *Learning Science in Informal Environments* postulated that school is the ideal space for enhancing science education, teacher training, and straightening the science pipeline. But overlooked and underestimated informal learning spaces should also be recognized, as many people visit libraries, museums, and other locations during out-of-school times. Feder et al. (2012) also took a historical snapshot of the early American education establishment of the 18th century, during which libraries, museums, and churches were perceived as the primary institutions of higher learning for the general public.

Early educational philosophers did not place value on what would later become the constructivist theory and Piaget's thoughts of people constructing their understanding through experience, on which Gerner Nielsen (2014) based his article, "Public Libraries and Lifelong Learning." Nielsen believed in lifelong learning as an essential for all people and in the library's role as a supporter and facilitator of learning—a dominant role in informal learning.

Nielsen's study coincided with the constructivist theory of learning cited by Bates (1986), Belkin, Oddy, and Brooks (1982), and Dervin and Nilan (1986). This current study examines the understandings of public librarians and their role in carrying out lifelong learning. The mission of public library is to provide lifelong learning to citizens. This study focuses on the perceptions of this role and the responsibility involved. This study's research methodology uses four research questions and an e-mail survey to present an empirical study of library users' perceptions and to develop a discussion on how users perceive the public libraries' role in the education, literacy, and the competency of public librarians as teachers (Nielsen, 2014).

The responses from the respondents of the study yielded three categories: (a) information resource center, (b) a place for independent learning, and (c) a place for support and guidance. The online survey brought forth the realization that the public librarians have some apprehension concerning teaching as the pedagogical underpinning, as teaching is not congruent with the requirements in the field of library science. However, librarians are willing and have demonstrated that, as of 2015, the programming efforts of community librarians throughout the United States are at an overwhelming 90% for programs directly related to instruction on the use of technology (Digital Inclusion Survey, 2013).

In the public realm of library service, many people may not have consistent access to Internet or technology, especially in underserved or minority communities and even in middle-class communities, as a result of the 2008 economic downturn in the economy. Access to technology is not always defined as having a smartphone or even access to the Internet. Many communities have one or both of these technologies but lack the skills or literacy that enables understanding of the written word. The digital divide has a two-prong effect for people who are at risk and susceptible to irregular periods of access to Internet due to the inability to maintain Internet services as well as challenges involving literacy. Cohron (2015) and Gonzales (2015) agreed that closing the digital divide in our population is dependent on maintaining access as well as maintenance of the existing technologies. Digital divide is defined as not having access to computers and the Internet in comparison to those who have. The difference in Internet usage and access is a relative one when access is evaluated by parameters such as income, race, education, age, ethnicity, and community type (Cohron, 2015; Rainie, 2017; see Figure 1).



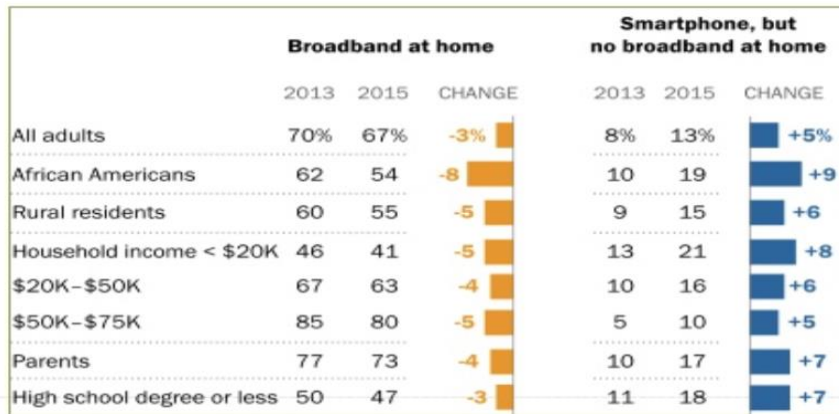


Figure 1. Internet usage 2015. Retrieved from <http://www.starnetlibraries.org/about/who-we-are/>. Reprinted with permission.

The Internet represents a significant transference in how people communicate, as asserted by Poe (2011) and Zickuhr, Rainie, Purcell, and Duggan (2013). In “A History of Communication: Media and Society from the Evolution of Speech to the Internet,” Poe (2011) explored the effects and causes of media development from speech, writing, print, audiovisuals devices, and the Internet and how each medium has progressively influenced how people organize themselves and what is believed. People wrote and shared daily experiences with others living a distance apart with the inception of a quill for writing in 1250. In 1836, Samuel Morse developed the Morse Code and the electric telegraph line, which created the first method for long-distance communication (Marshall & Mandell, 2011; Minkel, 2004). The progression of technology continued in 1889 with Alan Strowger and his patent for a telephone that would directly dial another telephone. In 1920, the first broadcast radio station went “on the air,” followed by the first commercial television broadcast in 1947. The development of electronic computer in the 1950s led to the first e-mail being sent in 1965 at the Massachusetts Institute of Technology. Kim (2005) argued that the Internet is the result of changing social and economic indicators, unequal distribution, and the changing modality of use around the world. The Pew

Research Center examined the broadband use of participants based on the following parameters: adult; African Americans; rural residents; household annual income of less than \$20,000, \$20–50,000, and \$50–75,000; parents; and education attainment at or below the high school level. Researchers have corroborated similar findings in the concerns for access. The NTIA survey (Goldberg, 2016) suggested that the issues are multifaceted and involve access as well as the ability to purchase a computer. In recent years, Internet access via smartphones and other devices seems to be closing the divide; however, access is not the only factor. Maintenance, locale, access in rural communities, literacy, and skills surrounding a knowledge of how to use said devices are factors in underserved and aging communities (Araque et al., 2013; DiMaggio, Hargittai, Neuman, & Robinson, 2001; Gonzales, 2015). Gilbert (2010) asserted that the ways in which users are not able to access information and communication technologies or find success with them is a deeper construct than initially realized or understood. Gilbert (2010) analyzed these challenges by studying individual social networks that are dependent on personal narratives. Therefore, the premise is based on personal circumstances such as the individual's residence, education, and occupation, which by extension includes race, gender, and the historical implications of social and economic inequalities. This current study summarizes a need for further research into how users excel or not, based on the information and communication technology they use and how the effect is measured based on their personal narratives—in turn looking at the broader inequalities.

The question of the digital divide began with the increase in Internet usage in the mid-1990s and is a major concern for populations who visit the public library. The age of computers and the Internet has brought forward many research efforts on the use of libraries, computers and the Internet. According to Zickuhr et al. (2013), most Americans view libraries as important part

of the community, housing and providing access to materials and resources that are seen as needed. Over 1,600 Americans over the age of 16 in the District of Columbia were surveyed during a 30-day period from March to April 2016, with results positing the public library as a viable institution. The dire need for programs that teach digital skills weighed in at 80%. Some divide on the use of books was 21% for removing books and 34% stating that books should remain, with creative usage of space to accommodate technology.

Regarding the divide in skill, Cohron (2015) was in somewhat of an agreement with Horrigan (2016b), noting not only the need for skill sets but also readiness as it relates to the ability to navigate technology in the user's personal life, whether it be for work or personal adaptation to technology as it relates to using and embracing of applications for everyday life. Horrigan (2016b) postured that through a cluster analysis of the surveyed, participants are grouped according to similar answers that also identified their readiness for the use of technology, noting those at the lower spectrum with a bit of hesitancy do not use technology for education but simply for learning how to use new devices such as smartphones.

The underlying theme of relevancy is evident as informal learning in libraries represents a digression from understanding the library as a depository. With technology, a physical visit is not a requirement. A person can reference resources electronically and use electronic databases remotely. The evolution of technology has naturally posited a discussion of the library's relevance as the need for physical space is not a necessity. The idea of libraries as places of experience in the community is becoming more discernible (Chadwick, DiPilato, le Conge, Rubin, & Shaffer, 2012).

As a result of these findings, some thought has been given to the concept of learning-on-demand as a type of lifestyle in modern society (McLoughlin & Lee, 2008). The public library

has become the bulwark of free access that promotes possibility through programming efforts, encouraging self-directed learning in underserved communities that may not have Internet access due to social, economic, or historical barriers. The development of STEAM programs in libraries allows underserved youth the opportunity to transform their lives, the communities in which they live, and by extension, the world by exposure to career paths in the sciences. The library building is then able to facilitate instruction and access in a very different way than before. The overwhelming demand for computer usage has prompted significant enhancements such as computers, software, Mondo boards, Wi-Fi, study rooms, and technology-driven meeting spaces.

Since 2011, the Pew Research Center has served as a depository of information in survey format that provides relevant data on the evolution of library usage and the explanation of patterns, public comment, and attitudes on the role of the library in the community. The information has largely been a positive representation of America's interest in libraries and their services. The survey over the last few years has shown a vast amount of interest in digital skills and the retrieval of information. The overall consensus of the people is favorable toward the public library, which is perceived as providing safe, creative, opportunities for everyone to learn.

Understanding the newly designed levels of library services calls for a higher standard of usage, one that has been exemplified in programming statistics for 2015 and 2016 (Rosa, 2017). During the end of the 21st century, a plethora of privately-funded organizations throughout the United States developed research-based programs in underserved communities, fostering connected learning in informal learning spaces. The spaces have been called Learning Hubs, Tech Centers, and Maker Spaces, providing not only access to information and technology but in some instances, safety and shelter. A growing population of young people in low socioeconomic

communities without technology will lack the necessary skills in a world that is rapidly changing as a result of technology if this issue is not creatively and urgently addressed.

Digital Media is one such organization working to address the issues of digital divide. Ito and Martin (2013) contended that a close examination of informal learning/connected learning principles in the public library can be a catalyst for socio-economic leverage for 21st-century youth. The post-doctoral research of the authors, in collaboration with Digital Media and Learning Hubs, connected with the learning network at the University of California. The report to the MacArthur Foundation sought to discover student needs in the community as well as in learning institutions.

The study used webinars and online discussion groups to explore how the library can affect school achievement and real-world opportunity through connected learning. The article, “Connected Libraries and the Future of Learning” (Ito & Martin, 2013) furthered the discussion on the phenomena of connected learning principles as it relates to public libraries and access for marginalized populations. This likely use of public space places value on libraries as places linking interest, academics, and career opportunities through connecting learning hubs. This research sought to inform and further research the importance of libraries in the conversation involving education reform.

As the concept of connected learning gains widespread momentum throughout the United States in museums, communities, and after-school programs, the effect has also surfaced in the public library. Connected learning has its theoretical underpinning in informal learning, which happens outside the classroom and beyond the school day. The public library continues its efforts to advocate for the development of youth. Many of the programs and resources contribute to the youth becoming informed and active participants in a democratic society (“Teens 13–18,” n.d.).

Multifaceted research initiatives and reports exist on the subject of after-school programs. The after-school programs are informal programs of action that address the concerns of youth not being adequately prepared for tomorrow's workforce, such as the Computer Clubhouse developed by the Massachusetts Institute of Technology (Kafai, Peppler, & Chapman, 2009). This program was designed to provide informal learning initiatives that are hands-on and accessible by all. These kinds of programs explore the role of informal learning and experimental play in public spaces as a complement to formal schooling.

Leadbeater (2000) presented several theories on the ideals of the contemporary knowledge economy, knowledge creation, and ideas about mobile schooling. Leadbeater (2000) also gave insights into the modernization of education through institutional reform that started in 1902 in England and Wales. The Butler Act of 1902 enforced participation in secondary school until the age of 14. The trend was constantly updated through the 1990s with the inclusion of three- and four-year-olds in formal education. Leadbeater (2000) explained the slow drive behind the trend, asserting that people find success through creativity out of thin air, and that perhaps the shift from an agrarian society to knowledge-based learning through science and education has proven to be beneficial, as people increasingly share and collaborate as a community of practice.

Many of the programs situated in public libraries exemplify the trend that Leadbeater (2000) identified, thriving with enthusiastic teens who have interest and strong desires to succeed. Programs such as Science-Technology Activities and Resources (STAR NET) provide a tenable way to introduce science education in the form of STEM programming. Foundations support science education by providing financial support for an initiative when public libraries do not have the means for such programs. This study, conducted in by Dr. John Baek in 2013, involved a semi-structured interview protocol with eight libraries selected by an online

community of practice website. STAR NET was funded by the National Science Foundation, which also promoted and supported the efforts of public libraries toward becoming venues for STEM learning.

Baek's (2013) study sought to determine the ways in which libraries support the development of STEM learning. The study used a non-probability method based on the convenience of the sample group of librarians. Eight librarians were selected from a pool of 54 librarians. The participants held various positions with the stipulation of five years of experience in STEM initiatives. The investigator concluded that libraries that seek to enforce the traditional mission of providing self-directed learning experiences are going to be considered STEM learning centers that foster literacy of all.

Baek (2013) surmised that STEM is not any different from any other service provided by public libraries that support lifelong learning. The support for lifelong learning is also the antithesis of the national dialogue on education. Anderton (2012) noted in "STEM, Teens and Public Libraries" that it is easier than one might think! The call is for new efforts in preparing our teachers with deeper content knowledge and skills so they can encourage science, technology, engineering, and math skills to meet the needs of future career paths. The article referenced the efforts of a teen services manager, Holly Anderton (2012) at the Carnegie Library of Pittsburgh, and her effort to bring forward the cause of STEM programs in a public library.

Anderton (2012) wrote of her attainment of a grant and the mechanisms by which the program was promoted, advertised, and brought to fruition. Anderton's (2012) experiences are evident in the statistical analysis reported by ALA's "Presidential Committee on Information Literacy" (2006) and "Public libraries lead the way to digital inclusion" (2014), and in the iteration of digital literacy and the demand for STEM-related programs in the majority of public

libraries. The applied digital literacy perspectives examined by Erickson, Meyers, & Small (2013) exuded with the great thesis of informal learning as a continuous engagement of young people that requires endless access to resources and tools in every aspect of community interaction—at home, school, work, and the social context of social media that intersects with learning. Informal learning not only makes up for the gaps; informal learning also fills the voids where a lack of instruction is present.

The Carnegie Library in Pittsburgh, Pennsylvania, intentionally decided to infuse STEM resources into the public library in 2009. The committee of stakeholders included the Finely Charitable Trust and the Shirus Charitable Trust by the PNC Charitable. Trust Committee. Charitable Trust. The team addressing learning science in informal environments and examined the potential of informal settings by reassessing the evidence of learning as to whether the assertion of the school setting had some distinct advantage for youth. The effort initially developed to give rise to the development of resources for the library on STEM. The resource collection was comprised of science, education, psychology, and media materials to cover a broad scope of the literature that is STEM-related including and materials to promote the acquisition.

While McLoughlin and Lee (2008) supported life learning as a lifestyle, Feder et al. (2012) asserted the importance of establishing clear, common constructs and language, as well as goals for informal learning environments. The potentiality of learning points as well as the assurance of continued funding to maintain the cost of technology and access are of primary concern. Learning science in informal environments provides a framework for dialogue from a public library perspective.



## **STEAM and the Public Library**

The public library was founded on the tenets of education as a resource for providing self-directed learning and services to meet the learning needs of the community and the underserved who want an entity that provides resources for enrichment (Baek, 2013; Gross, 2013). The public library connects with the people on their terms; everyone is welcome, no requirements exist. The power of America is our ability to reach the common person and provide opportunities for empowerment. The public library is the equalizer that reaches out to all, especially the disenfranchised. Although there is an increasing divide in our country, the public library has the opportunity to be the convener, bringing communities together with the provision of resources that make for a better tomorrow. According to Gross (2013), the public library delivers high quality public education for all that today includes innovative programs and new technologies that allow for meeting a potential customer in an unlikely place.

Drori (2000) asserted that science is an essential, social institution. The role of science in STEAM programs has recently gained a vast amount of attention. Educational programs from elementary school throughout college are emphasized. The interest has surfaced as a result of recent reports and surveys that continue to highlight a need to ensure the vitality of the United States and groups that support scientific literacy and national progress. Proficiency in the sciences rich learning environments is an essential factor in economic development, as demonstrated by the White House under President Obama's administration ("Fact Sheet," 2016, para. 2), which set out to increase the prevalence of science and math in school curricula. Environments that promote collaborative experiences that create a deeper understanding and high-quality learning opportunities. Programs that promote hands on exploration that involves investigating, learning and creating also promotes the arts in STEAM. STEM with art allows

hands-on art projects that includes constructing and tinkering of objects for constructing demonstrations such as makerspaces. The concept of hands exploration and creation provides a balance in the learning process. The overall goals emphasized the need for future careers in the sciences and the construct of art that will contribute to the economic growth and national security of the United States. Consider a few facts about students and STEM:

- Only 16% of high school students are interested in a STEM career and have proven a proficiency in mathematics (Hom, 2014; “Science, Technology, Engineering, and Math,” 2015).
- Fifty-seven percent of students who show an interest in STEM-related subjects tend to lose interest before graduation.
- Over 8.65 million workers will have STEM-related jobs (“A Look at the History,” 2016).
- The gap in needed skills in the manufacturing sector has a significant impact in the ability to fill the projected job market that was estimated to be 600,000 by 2018.
- Fifty-two percent of programs offered have been described as arts-based STEM programs.

The literature and statistics presented in various studies have substantiated that STEAM is a promising endeavor for the public library. The literature gives rise to the efforts of partnerships inside and outside of the public library and recognition to governing bodies that are scrutinizing the federal STEAM education effort and the status of STEAM education in the United States (Gonzalez & Kuenzi, 2012). The STEM Education Coalition is the largest proponent for science education at the national, state, and local levels, supporting policy development with the endearing mission to remain competitive on the world stage (Gonzales,

2015). The literature brings forth three areas of importance as it relates to STEM in the public library. The first examines informal learning as it relates to public libraries and the deep history and knowledge that has cultivated a new phenomenon of science education in “out-of-school” settings.

The public library as a life-long learning organization is one that goes beyond the formal education received in a school setting to the acquisition of knowledge from various entities. The desire for richer existence became a mantra for the 20th-century view of education. The public library as an informal learning organization has one of the leading responsibilities of not only providing pathways for information and creating an informed society but also providing assets such access, Internet, and computers that can lead to transforming STEM education (Pacios, 2007). The public library as a stakeholder is juxtaposed with other educational advocates. The public library’s relevance as the demand and technological platforms advance further substantiates this informal space as a possible influencer in the area of STEAM education and securing the democratic ideals of citizenry through programs that lead to economic growth, employment, and opportunities for underserved populations in the sciences.

As the trends increase, the library, as well as other organizations beyond the classroom, support science learning and fully understand the need for involvement. STEAM education is a science center organized for adults as well as children. Zoos’ film producers across the nation have joined the effort as a community-based need to strengthen efforts in science education (Hakala et al., 2016). Many of the spaces have been coined as “learning hubs,” spaces where individuals can connect and collaborate on their own terms (Penuel, Clark, & Bevan, 2016). Others are called tech centers, aimed at providing space to improve interest and achievement in STEAM initiatives.

## **Significance of Makerspaces in Public Libraries**

Makerspaces are also prevalent throughout the nation as libraries reimagine their space to create designated areas for creating, inventing, and learning-making stations mostly in areas where there is the highest need (Britton, 2012). Makerspaces in public libraries like other digital media programs provides education and access to shared resources in a public setting that emphasizes the need for time shared access to expensive equipment that would otherwise involve fees for use in membership-based makerspaces for business. There is also literature that speaks to the need for the maker movement and the crucial implications on manufacturing and economic stability that have implications and should be thought not just as a crafty maker faire event but one that has potential for job development (Fallows, 2016; Holman 2015).

The public library as free entity is providing meaningful programs that offer experience that could have lifelong value to its users. One organization addressing the needs of the community with makerspaces and digital media is Digital Media, for which Mimi Ito and Crystle Martin and asserted in the article “Connected Learning and the Future of Libraries” (2013) that the examination of informal and connected learning is indeed learning principles in the public library are a catalyst for 21st-century socio-economic leverage. The discussion on new technologies and new media and the engagement of youth in public spaces presents an important examination of future strategies for public libraries. You Media's focus on the digital and maker movement through project development includes learning, creating and play with open-source learning that lends itself to shared economic models that teach pooling of resources and time. With the increase of technology, the literature speaks to the practices adopted by youth. Some advantages and disadvantages such as networking and online practices affect relationships; however, a clear advantage is young people's ability to steer their interests especially as it relates

to STEAM programming in public settings. The opportunity is optional and allows for creativity that may lead to social and economic implications that youth may possibly benefit from in the future (Ito & Martin, 2013).

The University of California, in conjunction with the MacArthur Foundation, seeks to find out what students needs are in the community as well as the learning institutions. Webinars and online discussions are used to explore how the library can affect school achievement and real-world opportunity through connected learning. The article, “Connected Learning and the Future of Libraries” (2013) furthered the discussion on the phenomena of connected learning principles as it relates to public libraries and access for marginalized populations. This likely use of public space highlights the value of libraries as places linking interest, academics, and career through connected learning labs. This research seeks to inform further research on the importance of libraries in the conversation involving education reform.

Many programs thrive within the public library as a result of teens who have an interest and strong desire to learn and explore. Programs such as STAR NET provide a tenable way to introduce libraries to science education by providing financial support for programs that libraries are not able to fund. P. D. Investigator’s research analysis on public libraries as places for STEM learning interviewed eight librarians and the ways in which the collaborative efforts of partnerships benefited from the initiative. The study, conducted in 2013 by Dr. John Baek, involved a semi-structured interview protocol with a selection of librarians by an online community of practice website (“STARNet Science-Technology Activities & Resources for Libraries,” 2018) Science and technology activities and resources are funded by the National Science Foundation, which promotes and supports the efforts of public libraries and their desire to be venues for STEM programming.

Using a non-probability method, the study was at the convenience of the eight librarians chosen from a group of 54 librarians. The professional position of the librarians varied with the stipulation of having at least five years of experience with STEM programming. Investigator (2012) surmised that STEM is not any different from the other services offered at a library that supports lifelong learning.

The support for lifelong learning is also the antithesis of the national dialogue on education and the broader impact of STEM education of all aspects of society as well as research (Anderton, 2012). STEM research learning is a rapidly growing body of scholarship for the next generation of STEM learning research and the implications for the public library (Bailey et al., 2016). The National Science Foundation supported the efforts of the American Library Association and, by extension, the public library. As the keystone entity in the community, the library becomes the information stronghold for many, especially during the summer when schools are not in session—a key time when libraries become venues for STEAM learning.

### **The Public Interest in Libraries**

ALA, IMLS, and IPAC are the major sources of definitive data on public libraries. The overall perception as determined by visits and program interest was conveyed in the Public Library Survey. Other organizations conducted surveys that provided tangible information and research supporting the findings of the aforementioned bodies. One such organization is the Pew Research Center, a nonpartisan research bank that explores public opinion of issues and trends that shape the future. The goal is to create data and opportunity for the general public to engage and inform the public (Funk & Hefferon, 2018).

## **The Public Library and STEAM Education**

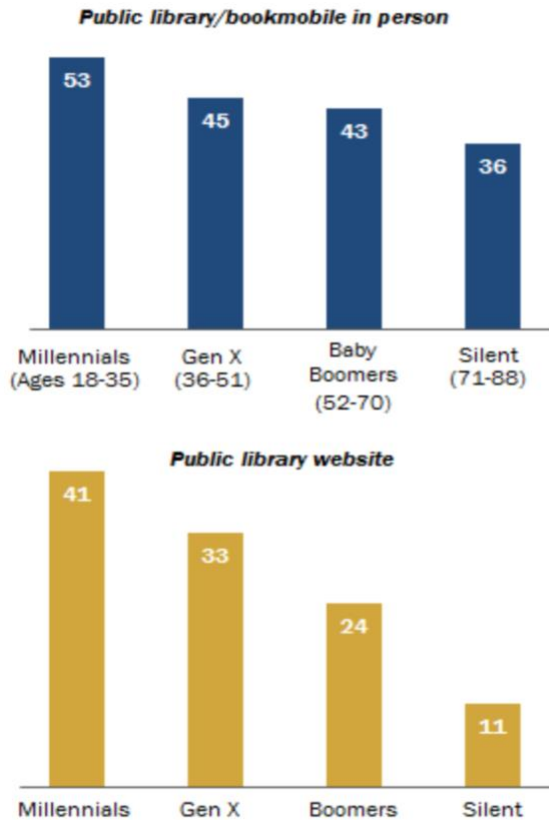
While public libraries across the United States reimagine their community roles as STEAM educators, society at large will draw collectively on resources from a number of initiatives to gain knowledge to improve science literature (McComas, 2014; National Research Council, 2011). This emphasis reflects not only the resources that the public library offers but also on the resources of other organizations that provide services for youth. As a result of the increased programs and interest, a proven leverage and public trust in libraries exists for their neutral space for learning and career exploration. The American Library Association and the Digital Inclusion Survey conveyed an increase in demand and attendance in STEM program efforts in 2014–15. The survey has consistently gathered statistics since 1988 and is the only organization that has extensive data on libraries nationally. The study is conducted annually by ALA (2017) and the University of Maryland’s Information Policy and IPAC. The trends for libraries have been consistent (“Issues and Trends,” 2015; Pundsack, 2016).

A recent analysis of data that compared the data of the public library with findings from the Pew Research Center asserted the following:

- Persons between the ages of 18–25 are more likely to use the public library.
- Millennials used the public library more frequently than other generations.
- Younger generation are more likely to use the public library website compared to older generations.
- 31% of adults used a public library’s website within the last year, which is similar to their usage in 2015 (see Figure 2).

## About half of U.S. Millennials have visited a public library or bookmobile in the past year

% in each generation who visited a \_\_\_\_\_ in the past 12 months (2016)



Source: Survey conducted Sept. 29-Nov. 6, 2016.

PEW RESEARCH CENTER

*Figure 2. Millennials are the most likely generation of Americans to use public libraries. About half of U.S. Millennials have visited a public library or bookmobile in the past year. From Internet usage by generational groups. A. Geiger (2017). Pew Research Center. [http://www.pewresearch.org/fact-tank/2017/06/21/millennials-are-the-most-likely-generation-of-americans-to-use-public-libraries/ft\\_17-06-21\\_librariesabouthalf/](http://www.pewresearch.org/fact-tank/2017/06/21/millennials-are-the-most-likely-generation-of-americans-to-use-public-libraries/ft_17-06-21_librariesabouthalf/) Copyright 2018 by Research Center. Reprinted with permission.*

The Pew study by Geiger (2017) also asserted that the increase of use by millennials is likely a result of the recent changes in today's public library. The availability of computers, Internet connections, and programs that provide introduction to and use of high-tech gadgetry such as program spacing for coding, makerspaces, and 3-D printers created a growing interest of

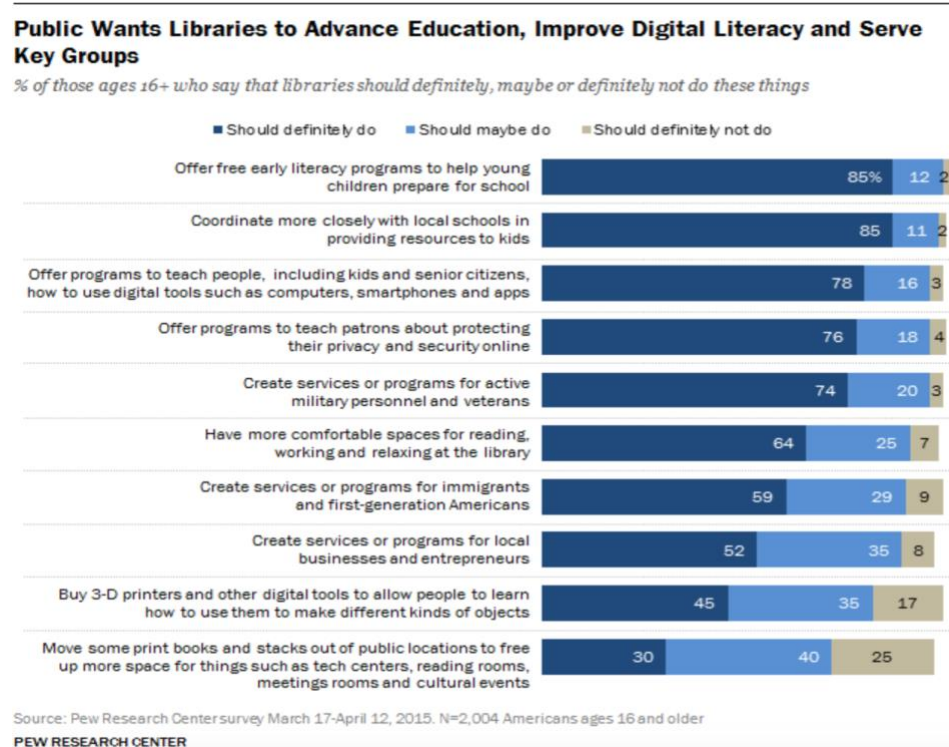


a tech-savvy community. In order to provide much of the technology, many libraries have undergone facility renovations to their infrastructure in order to support the use of computers. Research has shown that the average public library structure across the United States was built around 1970; therefore, many of the public libraries that are meeting the technology trends of today have renovated to meet the demands of a digital age (Freeman, 2017).

The survey specifically noted the wording in the survey so as to delineate between public libraries and academic libraries. Across all generations, use of the public library mobile applications is less common. The Pew Research study also conveyed a greater use of the library by women than men (54% and 39%). Similarly, persons with college degrees showed greater use of the public library and services offered than persons with a high school diploma (54% and 40%). Finally, parents of young children were more likely to use the public library than those persons without children (54% and 43%; Geiger, 2017).

Parker (2015) asserted that millennials will likely exist with a lower standard of living and economic possibility due to the debts from previous generations; however, (Howe, Matson, & Strauss, 2000) connoted a perspective of influence and adaptability by asserting that millennials, as a positive generation of thinkers with well-intentioned belief structures, will ascribe to community building. (Howe et al., 2000) described millennials in great numbers as better educated, more affluent, and having positive social habits. These attributes also yield a greater outlook on racial and cultural diversity (Taylor & Keeter, 2010). The element being of technology planners could be deducted as one of the reasons, in support of the Pew Research Center's study, that millennials are the generation that is keeping the public library alive (Livni, 2017). The Pew Research Center study (Rainie, 2014) stated that millennials grew up online, understand the technology, and see the resources as a mechanism for attaining success, with

ready access to the Internet, computers, and the extra services surrounding technology and the informal opportunities for learning, such as access to 3-D printers for creating useful things. Many millennials are also parents (Livni, 2017) who are raising the next generation of tech-savvy users whose parents are accustomed to library use. The Pew Research Institute added a survey to the literature that examined the overall use of public libraries, resulting in a conclusive return of 91% of Americans finding value in the public library and in underserved communities, the public library is very important to the community (“Public Wants Libraries to Advance Education,” 2015). STEM education in public libraries is essential (Jakubowski, Riendeau, & Shtivelband, 2017) for achievement and diversity within the science educational efforts (see Figure 3).



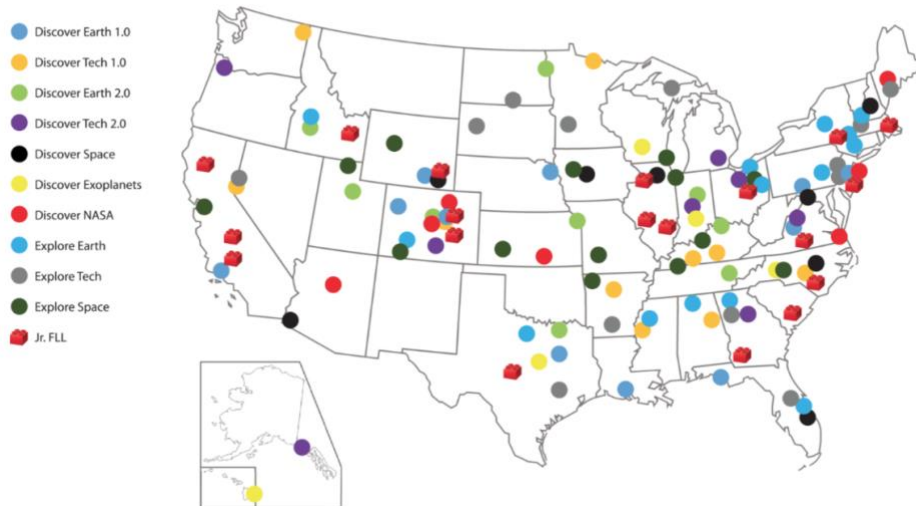
*Figure 3. “Public wants libraries to advance education, improve digital literacy and serve key groups.” From *Public Libraries and Education*. Pew Research Center, [http://www.pewresearch.org/2015-09-15\\_libraries\\_0-01/](http://www.pewresearch.org/2015-09-15_libraries_0-01/). Copyright 2018 by Pew Research Center. Reprinted with permission.*

Although little statistical reporting has been done, substantial evidence exists regarding the establishment and implementation of makerspaces and partnerships with for-profit organizations. According to Jakubowski et al. (2017), STEAM education programs in public libraries are essential to the increase of achievement and diversity within the sciences and STEM-related careers. The Afterschool Alliance (2015) also explained in its literature that ethnic/minority children who attend afterschool programs initiatives are more likely to participate in STEM programs. However, some social and economic barriers involving fees associated with such programs prevent many from participating. Although the public library is the place for learning (Baek, 2013), proven in the representation of programs, and responds to current trends, the public library can very well be the place to address not only the needs for increased educational efforts in math and science but also the level of participation of the underserved. The public library has in essence arbitrarily supported the addressing of barriers with the development of SciGirls CONNECT (“What is SciGirls?” 2018), a program that provided a place for girls to collaborate with equity and fairness, using hand-on projects and creativity in ways that were meaning to the participants (Jakubowski et al., 2017). Although the public has been able to develop, promote, and implement programs across the nation, much of the development has been done through partnerships that support public libraries, such as the STAR Library Education Network (STAR Net).

STAR Net is a collaborative effort between the Space Science Institute (SSI) and National Center for Interactive Learning and the American Library Association, providing programs, exhibits, and training for the public libraries, lunar planetary institutes, and the After School Alliance. Other affiliate organizations also partner together in efforts to raise awareness and potential for students in the area of space science, technology, earth science, and engineering

through the use of hands-on activities, professional development opportunities, and exhibits funded by the Institute of Museum and Library Services, NCIL, and the Cornerstones of Science, which is a clearinghouse of resources for public libraries and their staffs (STAR Net, 2018). STAR Net reported in its project impact statement that over 1,500,000 persons visited STAR Net exhibits, 125,000 persons participated in STAR Net sponsored programs in public libraries, and over 3,900 professional librarians are members of the STAR Net community. In addition to STAR Net, other programs are connecting with youth through the public library in the areas of science. Dr. Mizuko Ito introduced a research model for engaging teens through social media and technology. The model was then implemented as YOUmedia Chicago, funded by John D. and Catherine T. MacArthur Foundation and placed in the Chicago Public Library. You Media focuses on connected learning in public spaces as a catalyst for research and practice on self-directed learning. Dr. Ito conceptualized YouMedia (Santiago, 2012) and surmised that youth use technology as a means for socialization and expressing an interest in the sciences. The Cultural anthropologist, Mizuko Ito developed You Media, a 21st-century learning space, as a result of a living and learning digital media project. The latest space is centered in the Chicago Public Library's Harold Washington Library (Bannon, 2012; Santiago, 2012). The model was developed through an ethnographic research model that studied 700 youth in activities. The study found three distinctive areas of learning around the theme of digital media. The three areas are described as "Hang Out," "Mess Around," and "Geek Out" (HOMAGO), which was developed by Ito, and resulted in a sleuth of research and collaboration that targets youth and their driven interests in media development and the learning that they experience while connecting to their contemporaries. The trend has spread across the United States as several public libraries have

extended their spaces to encompass a You Media lab. The following map denotes the states that have media labs in libraries that have embraced this emerging trend (see Figure 4).



*Figure 4.* Nationwide Reach, STAR Net programs. Space Science Institute, the National Center for Interactive Learning, 2018. From STARnet, Science-Technology Activities & Resources for Libraries website. <http://www.starnetlibraries.org/about/who-we-are/>. Reprinted with permission.

In 2011, You Media engaged with yet another public library in Miami, Florida, emphasizing the use of technology and the public library as a place for innovation for teens. The Miami Dade Public Library was able to act on the collaboration with the support of a grant funded by the James S. and John L. Knight Foundation. The space invites teens to explore, create, and read with their peers, mentors, and librarians. This program is significant to Miami-Dade County as the population amasses over 107,000 residents, with the vast majority being of African American descent and under the age of 18. As with all You Media models, teens participate in programs that are certificate-bearing with the completion of the required units of work (Bannon, 2012; Santiago, 2012).

You Media (Bannon, 2012; Santiago, 2012) has provided a greater sense of connectivity with the public library through reading and research so as to proliferate the element of lifelong learning and literacy. Consider these statistics generated from two of You Media's 17 locations:

- 43% of participants are without Internet in their homes,
- 41% use the public library as their primary source for accessing the Internet,
- 35% of teens had never used a MAC prior to entering the You Media program,
- 46%t did not own a digital camera,
- 35% had never use software to record music,
- 86% had never produced music on any software,
- 96% collaboration with teens inside of You Media while 76% say they collaborate with teens outside of You Media,
- 93% say that the You Media Miami program has changed the way they view the library (Ito & Martin, 2013; Santiago, 2012).

The initial, single purpose of the public library was to provide resources for continuing education through informal learning opportunities in a public space (Pungitore, 1995). The historical context highlighted the more industrialized cities and the need to inform citizens in the mid-19th century. Stephen Kern asserted in the book *The Culture of Time and Space* (2003) that the creation of new technologies and culture began around the 1880. World War I brought forward a changing in thinking about time and space. Elmborg (2016) further established that the development of the telephone, wireless telegraph, movies, medical equipment such as x-rays, and modes of transportation such as the bicycle, automobile, airplane provided the foundation for today's transformation of communications.

The transformation of American society as described by Surdam (2015) involved rapid changes from agrarianism to industrial and post-industrial 20th-century society. The technology evolved to support the first commercial radio station and the beginning of a national media culture. Thereafter, the automobile and trains provided a connectivity across the nation. Like no other time in history, the transportation and communication lines gave people the power and ability to physically move themselves and their ideas across the country.

As many cultural organizations had begun their efforts, the public library was taking shape as well, highlighting Andrew Carnegie's idea of providing access to information as a means of self-education and lifelong learning. The institution's aim was to first Americanize immigrants, providing civility and manageability, and later to serve the needs of the elite, educate the masses, and provide access to materials for those who would someday become leaders.

The literature also speaks of the STEM Education Coalition as one organization that seeks to lead, support, and raise awareness in Congress and other organizations about the democratic ideals of learning and STEM. Having a precise understanding of STEM programs and how they interconnect science, technology, engineering, and math disciplines gives power to the improvement of the economy and society. This shared responsibility, as noted by the STEM Education Coalition 2017 Annual Report (2018), is a means for improving the way kids learn and understanding the need for future preparation in the sciences.

Critical thinking and problem-solving help build the skill sets needed to develop and solve the tough problems of tomorrow's workforce. The future of the economy and STEM is a necessary prescription for preservation of the nation's vitality in the international arena of discovery and innovation ("Science, Space, and Technology Committee," 2017). According to

James Brown (as cited by Vilorio, 2014), in 2015, President Barack Obama reauthorized what was formerly known as the 1965 “Elementary and Secondary Education Act” as the “Every Student Succeeds Act” (2015). According to “The Case for Investing in Out-of-School Learning as a Core Strategy in Improving Science, Technology, Engineering, and Mathematics (STEM) Education” (2016), STEM education is closely related to the nation's prosperity and the provision for a well-rounded education.

According to Nager, Ezell, Cory, and Ezell (2015), one job in the high-tech sector leads to 4.3 jobs in goods and services. STEM-oriented job holders earn 11% higher wages compared to their same degree counterparts in other jobs (Brown & Peterson, 2013), and the fastest growing occupations in the next decade will require some STEM knowledge (Riel, 1994). The ever-changing world demands an adaptable workforce, one that is a national priority requiring reforms, policy development, and the recognition of informal settings as viable learning spaces that support the educational initiatives of our nation. This summary briefly surmises the direction that is needed to support STEM strategies, best practices, and policies needed to support today's youth as they prepare to enter the workforce.

Positioned opportunities are open for public libraries to host informal learning settings that present long-term learning, economic stability, and social change for all but specifically for the underserved. The public library can potentially reach segments of the population who are under-represented as a result of social and economic disparities, thereby providing some leverage in access to low-performing schools and diverse communities affected by poverty. This catalyst for change, as libraries extend and expand their reach through STEAM programs for women, Hispanic Americans, Native Americans, and others, is becoming more evident as nonprofit and for-profit foundations and science-related organizations assist with funding for much needed



initiatives that provide opportunity for engagement in public spaces (Bureau of Labor Statistics, 2014).

In May 2015, over 8.6 million jobs were STEM jobs, which amounted to 6.2% of the total employment population. Computer-related fields comprised 45% of the STEM jobs, with 19% in engineering. Diversity in STEM jobs varies by occupation; however, the racial and ethnic distribution of the STEM workforce is 71% non-Hispanic white, 15% Asian, 6% Black, and 7% Hispanic (Landivar, 2013).

The public library is a place where the community garners support and value. Whether school is in session or not, the opportunities are available for everyone regardless of who they are. According to Semmel (2015), the public library can serve as the community-based mainstay that provides cross-sector STEM collaborations. There are three places that are described as spaces that people spend the majority of time with the home being first and work in second place. The public library has emerged as the third place as a space for community gathering where people connect and share information looking to the future (Coppola, 2010). The public library provides a framework for STEAM programming in public libraries as one of instruction and resources based on the nature of the organization and its core value of lifelong learning. Collie (2013) defended libraries as places where the public can learn the techniques for finding pertinent information that will be the guiding force for future interests and encourage the desire to attain more knowledge. Collie (2013) endorsed lifelong learning as a core value. The ultimate desire is to provide opportunities for success as the one civic organization that is free and open to the general public regardless of gender, sexual orientation, religion, status, socioeconomic status, ability, or race. Everyone is someone in the public library and everyone has possibility.

The shift in service and the emergence of technology are being addressed in research, examining both the need for aggressive action and the need for collaboration around the national topic of science education in the United States in both schools and informal learning spaces (Freeman, 2017; Omdal et al., 2006). Freeman (2017) asserted that the momentum has begun, continues, and clearly signifies that the public library is an active participant in the STEM movement, with a vast amount of activities that support 21st century learning initiatives.

Omdal et al. (2006) addressed the national crisis in the areas of science, technology, engineering, and mathematics. They proposed solutions to a threatening crisis in science education for the State of Colorado and by extension, the nation. The economic effect of STEM education is a topic of significant value as all states review the statistics from the Bureau of Labor Statistics (BLS) as well as White (2018).

The STEM Index provides an interactive measure of science activity in the United States since 2000. While much has been accomplished, according to the Index, recent indications are that instead of STEM being a priority, as it was with the previous administration's federal programs, STEM funding is on the chopping block for the fiscal year 2018. The economic impact is of concern as projections estimated the need for 8.65 million workers in STEM-related jobs within the next few years, according to STEMconnector. A few sectors will have an even greater need in the area of manufacturing, which is estimated to need 600 million positions related to a STEM skill. In the years between 2011 and 2015, cloud computing jobs alone yielded 1.7 million jobs. The U.S. Bureau of Labor Statistics (Fayer, 2017) stated that the majority of STEM jobs will be in the following areas:

- computing—71%,
- traditional engineering—16%,

- physical science—7%,
- life sciences—4%, and
- mathematics—2%.

Disenfranchised populations that are not represented in the college community's STEM fields or areas of related studies that provide skill sets for future jobs are also of grave concern (Camera, 2017). The following data from the National Science Board (2014) and the National Academy of Sciences (2007) exemplify the need for reform and a rigorous strategy on all educational fronts, including the public library as a bridge that supports the formal institution outside the walls of academia:

- Between 2000 and 2013, an average of 37.6% of high school males reported having interest in at least one STEM discipline versus 14.8% of females.
- In 2013, the average Scholastic Aptitude Test (SAT) math score for white students was 534, compared to 461 for Hispanic students and 429 for Black students.
- As high school students' interest in STEM has waned, their scores on international assessments like the Program for International Student Assessment (PISA) have also dropped. In 2000, the average U.S. PISA math score was 493. In 2012, that average score dropped to 481. Compared to other developed countries, the United States is near back of the pack (National Science Board, 2014).

The need for preparation before college is essential if we are to competitively address national security, innovation, climate change, medical discovery, and new information industries that are grounded in STEM. The American College (ACT) has actively provided data through yearly STEM reports discussing and highlighting the relevance of STEM education and future workforce needs. A lack of preparation will adversely affect the workforce (National Academy

of Engineering, 2008). The STEM pipeline has a steady decline with fewer graduates with bachelor's degrees in STEM fields (Tierney, 2000). The highest percentages of STEM degrees (36%) was achieved in the early 1960s, with slight fluctuations that continued through the 1970s. In the 1980s, the fluctuation saw a drop to 35%. The 1990s presented a low of 31%. Some improvement was realized in 2006 with 32% STEM degrees (Tierney, 2000). The “STEM 2026” report (Tanenbaum, 2016) provided research on needed innovation as well as equitable access to a higher level of science education initiatives. The report sought to create a dialogue about the need as well as build tangible evidence in support of practices involving science, technology, engineering and math (STEM) education. The value placed on public libraries as informal learning spaces can that provide valuable educational opportunities for students, supported by policy and developed funding, will help in the effort of supporting the democratic ideals of society (Stephens, 2015).

## **Chapter Summary**

Public libraries across the nation have in some ways reimagined their roles, spaces, and services driven by technological advances (“Library as Place,” 2012). The shift in service implementation has leveraged resources and participation with a plethora of initiatives to address the digital divide with courses, computers, and instruction of every aspect of job readiness and other societal needs for acclimating aging populations as well as clientele that has a need for access and literacy on varying levels. The public library supports and accepts all without judgment. A gradual increase in science literacy is the current trend, based on the needs and desires of the community and the existence of technologies that have forwarded the cause for STEM and STEAM education in the public library (“Issues and Trends,” 2015).

Although the public library has always been the *convener of possibility*, the dialogue that seeks to gain a balance between advocacy and inquiry that creates an alternative future through community (Bohm, 1996; Block, 2008). The public library's mission is to serve the entire community including the underserved. It now has the formidable task of being an equalizer in STEM, providing opportunities that have never imagined, foundational hands-on skills that prepare youth for careers in the sciences, and training alongside an expert in the field through cross-sectional, collaborated initiatives in a public setting. The public participation across the nation speaks to the desire, need, and creative innovation that youth are yearning for as they to return to the library not only for socialization purposes but creative problem solving with technology (ALA, 2017; IMLS, 2017).

The STEM momentum continues; however, the momentum needs a methodology for tracking the success of informal learning opportunities in the area of science, technology, engineering, arts, and math in public libraries, identifying the inequalities present for girls in the learning process and women in the workforce (Cheryan, Master, & Meltzoff, 2015; Landivar 2013), and documenting the representation of minorities in STEM fields (Graf, Fry, & Funk, 2018). The public library has been placed at a unique crossroads with the mitigating responsibility to leverage educational opportunities for students as an informal learning entity, as asserted by Datum, a research evaluation consulting firm in its report to the Space Science Institute (2018). The integration of curricula and the resources that anchor STEM education will provide a public square where the community can gather to discuss issues such as education and the needs of the people (Garmer, 2014).

However, the articles “Developing the STEM Education Pipeline” (2006) and “Diversifying the STEM Pipeline” (Boelter, Link, Perry, & Leukefeld, 2015) suggested that

interest in STEM degrees at the college level is dwindling. The decline is attributed to the facts that most entering college students do not remain with their initially chosen course of study and minorities and white persons of low income are underrepresented in STEM fields due to a lack of exposure to STEM education. American College Testing (ACT), a mission-driven, non-profit organization, seeks to create and explore college readiness for students entering higher education. ACT has been instrumental in providing tools necessary for assessing science, technology, engineering, and math that support STEM careers. The provision of assessment research that guides a community or parents, teachers, students, administrators, and policy makers on the skills for future career paths has found that early participation through classes and career planning is more likely to result in students choosing to major in STEM fields (ACT, 2006; Boelter et al., 2015). The retention of students in the STEM fields is an area for future. When assessing the retention issue, the Excel program, funded by the National Science Foundation, suggested multiple solutions for addressing the decline of STEM degrees and reasons for the decline (Dagley, Georgiopoulos, Reece, & Young, 2015).

Excel recommended preventative methods for STEM degree decline through holistic approaches such as social programming, math assistance, and the involvement of the community. Similarly, the STEM Career Interest Survey (STEM-CIS), (Kier, Blanchard, Osborne & Albert, 2013) suggested that the interest level of middle school students is developmental and maybe the apropos time to foster interest in the sciences. STEM-CIS has developed a single factor instrument that measures reliability through six stages of developing an interest in a STEM career. The students tested were in grades 6–8 and were residents of underserved communities (Kier et al., 2013). Perhaps public libraries could explore such a holistic approach to reaching youth in a public setting before high school and college by (a) offering informal opportunities

that foster possibility for all with intentional thinking about implementation methods (Lettvin, 2015; Shilling, 2015); (b) partnering with STEM companies (Walters & Bishop, 2018); (c) storytelling with effect, supported with data and STEM journaling (Awasom, 2015); and (d) combining the resources of professionals and local educational institutions to create sustainability nationwide (Hurtado, Newman, Tran, & Chang, 2010).

The greatest challenge today exists in the ability to produce a clear public mandate to assert the public library as an essential part of the educational ecosystem by promoting informal learning opportunities and digital literacy (Rainie, 2016). The Pew Research Institute (Horrigan, 2016a; Rainie, 2014) suggested that public libraries should deliberate some critical strategies as technology continues to influence the viability of the public library. The future of libraries will be dependent on librarians' abilities to forecast and deliver innovative efforts that support the national needs of an informed citizenry.

The formation of a national policy that is inclusive of the public libraries needs to recognize the public library as a viable organizational partner within the educational ecosystem that supports science literacy. The continued change in service and educational support for a public organization whose mission is hinged on lifelong learning highlights the importance of informal learning experiences and their spaces. Libraries across the United States have been reimagining their roles by the leveraging resources and public participation and trust that has been developed. The STEM/STEAM momentum continues throughout the nation and needs a methodology for extracting the success of informal learning opportunities in that area of science, technology, engineering, arts, and math in public libraries. The process of leading the change will be exhibited through the methodology that engenders new ways of thinking in the execution

of the mission for the American Library Association, leading to future innovation and engagement along with formal learning partnerships.



## **Chapter 3. Research Design and Methodology**

### **Introduction**

The purpose of this study is to investigate existing and needed strategies employed by informal learning spaces such as public libraries and their implementation of STEAM programs. The study also addresses the challenges faced in the development of STEAM programs in public libraries. This investigation will also, by extension, measure related successes in the public library and seek to discover overall recommendations for implementation of exemplary STEAM initiatives that substantiate the public library as a recognized entity in STEAM education. The effort will strive to show several samples representative of regional achievement within the United States.

The lack of information regarding the strategic mechanism for the implementation of STEAM in public libraries has been outlined in the preceding chapters. This chapter describes the nature of the study, including the research design, and the research methods employed to understand the STEAM experience in public libraries. This chapter also describes the interview protocol, a statement of personal bias of the principal investigator, and the data analysis process.

### **Restatement of Research Questions**

This chapter describes the research methods that were applied to achieve the objectives of this study, which is to primarily answer these four research questions (RQ):

1. What strategies and practices have been implemented in public libraries that focus on informal learning opportunities related to STEAM?
2. What are the challenges that public libraries face as they relate to the implementation and development of informal learning programs focused on STEAM?

3. How do public libraries measure success within informal learning programs related to STEAM?
4. What lessons have been learned in the development of informal learning spaces focused on STEAM in the public library?

### **Nature of the Study**

The focus of this qualitative research design is to determine the best practices for the implementation of STEAM initiatives in public libraries. Qualitative research, as delineated by Creswell (1998), is the process by which the principal investigator develops inquiry based on distinct methodological traditions of inquiry that scrutinize a social or human problem. Qualitative research, multi-method in approach, studies phenomena in their natural setting in an attempt to make sense of the meaning that is brought forward by the people (Denzin & Lincoln, 1998). The investigator's theoretical lens, as described by Creswell (1998), is influenced by social science theories of leadership, attribution, political influence and control, and many other factors that control the interpretive framework of the research. The interpretive framework is guided by a set of beliefs and philosophical assumptions that the investigator brings to the research. These beliefs and assumptions are important because they inform the body of the work. Therefore, the investigator's initiative is to undertake qualitative study by complying with the philosophical assumptions and amalgamating their own worldviews that shape the charge of the research. The qualitative method usually requires data to be gathered by observation, interviews, or focus groups and may also include written documents and case studies. Qualitative research involves collecting numbers on the meaning of behavior as opposed to collecting numbers of people and the behavior displayed. The data collection also involves using open-ended questions and fewer tools for a focus on answering the how and why, whereas the quantitative approach

emphasizes the who, what, and when questions. Data are usually gathered by observation (Creswell, 1998).

**Strengths.** The strength of qualitative methodology and the theoretical perspective of phenomenology lies in the understanding of social phenomena from the participants' perspectives and understanding how the world is experienced (Taylor, Devault, & Bogden, 2015). This design also allows the researcher to use personal motivation and interest to further a study—a strength in the completion of a dissertation (Maxwell, 2013). The collection of first-hand data is also an advantage in the interview process that yields information through open-ended questions (Maxwell 2013; Patton, 2002,). Jack Douglass (1970) wrote that the forces that move human beings are beyond physical movement and include the development of internal ideas, feelings, and motives. These elements are significant to the interpretation of the constructs and beliefs behind the actions in studying a phenomenon. In this study, the design of the qualitative research approach will provide and strengthen opportunities for insight into local perspectives of the study's designated population.

**Weaknesses.** The phenomenological design has numerous strengths that led to the use of this methodology for this research design. A few weaknesses are also recognized in the process. While the phenomenological method is credible research, its limitations are recognized. One such weakness is noted by Janesick (2016), who asserted the need for the researcher to disclose personal biases and beliefs prior to the actual study. The qualitative research methodology also imposes a vast amount of data that could possibly be overwhelmed by an inability to limit the scope of the study as well as the laboriousness of the process and time consumption (Bryman, 1988; Creswell, 2013; Janesick, 2016). Patton (2002) suggested the interviewer must give due

diligence to the process, present the data, and communicate what is brought forward in alignment with the purpose of the study.

## **Methodology**

The fieldwork for this study involved a phenomenological method that will explore the lived leadership experiences of the subject. The phenomenology of practice refers to the kinds of inquiries that address and serve the practices of professional practitioners as well as the quotidian practices of everyday life (Van Maanen, 1979). Phenomenology studies the meaning of experiences as they are lived, providing opportunities to collect descriptive, reflective, and interpretive data and engage a means for conversation on the essence of the experiences (Richards & Morse, 2013; Van Maanen, 1979).

Phenomenology gathers lived experience descriptions—not opinions, views, beliefs, interpretations—but direct descriptions (depictions, renderings, portrayals) of an experience as lived through in a particular moment of time (Van Maanen, 1979). The approach generally phrases the phenomenon as a single concept (Creswell, 2013). In the context of this study, the single concept under consideration are the strategies and best practices of librarians and the implementation of STEAM education initiatives.

The methodology of this study rests on the exploration of a problem (Creswell, 1998). The problem this study addresses is the lack of strategies for promoting STEAM efforts in the public library. In the qualitative research design approach noted by Creswell (1998), the purpose is to discover best practices for the development and implementation of STEAM initiatives and informal learning environments such as the public library. The methodology also has a theory base that asserts a connection between two or more phenomena. Theory guides the research and organizes ideas. The theoretical basis for this study is phenomenological and is used to

understand several individuals' communal perspectives surrounding a phenomenon based on a qualitative approach. The phenomenological approach delves into a clear understanding of common experiences in order to develop best practices, potential policy, and the features of the phenomenon related to STEAM education in the public library. This study will scrutinize information through semi-structured interviews that will assist in establishing best practices to (a) improve the nation's competitive edge with students in the areas of math and science, and by extension, improve school performance; (b) include all children; and (c) address the need to increase the leverage of female and minority participants in STEAM career pathways. The public library, as a lifelong learning institution, is situated as a free, public entity that can contribute to the democratic ideals of success in increasing ways through informal learning programs specifically related to science education.

**Structured process of phenomenology.** This qualitative research will employ a phenomenological design that embraces a specific school of philosophy and research methods in the form of three different schools of thought: transcendental phenomenology, hermeneutic phenomenology and existential phenomenology. This phenomenological study will explore the meaning of the lived experiences of several librarians about the concept or phenomenon. Phenomenal study examines the structures of consciousness in the human experience (Polkinghorne, 1989), which has its genesis in the philosophical perspectives of Edward Husserl (1859–1938). The philosophical assumptions and interpretive framework of this study are axiology, which describes the way in which values are discussed with both the researcher's and participants' views reflected. The assumptions also include social constructivism and the inductive method of expressed ideas that are obtained through methods that include interviewing, observing, and analysis of text (Creswell, 2013).

**Appropriateness of phenomenological methodology.** Phenomenology gives a description of the immediate experience, attempts to capture the experience as lived, is a method of knowing that begins with the concepts themselves (free of perceptions), and is a method of learning about another person's subjective world. In the real world, conceptualization involves everyone using their own preconceptions. Phenomenology ventures to make clear our receiving of information and the discovery of what is reality. Phenomenological research includes three approaches to derive what is (a) an existential dimension, examining what is distinct in experience and what is common among those sharing the same events; (b) hermeneutics phenomenology, involving the thematizing after collecting descriptions (Hein & Austin, 2001); and (c) transcendental phenomenology, which ignores the researcher's and participants' points of view and examines the data, looking at shared beliefs, experiences, and views (Creswell, 1998). This research provides a conceptual framework for meaningful practice using parallels as described in transcendental phenomenology, and therefore, transcendental phenomenology is best suited for the topic at hand. The findings will be aligned and descriptive of the participants' experience without the researcher's frame of reference.

The overarching goal of phenomenology is to develop research that is a pure self-expression without the voice of the researcher. Phenomenology attempts to understand the lived perceptions, perspectives, and understanding of situations (Van Maanen, 1979). Every research methodology has a set of intrinsic limitations (Leedy & Ormrod, 2005). These potential weaknesses are identified (Creswell, 2005) and can be a threat to the validity of the study. Creswell (2003) identified three fundamental challenges in developing an understanding of a phenomenon when using Moustakas's (1995) methods for data collection. Moustakas maintained that once the data has been collected, the descriptions are what was expressed and how it was

expressed—the essence of the data, not an explanation of the data. First, prerequisite knowledge of the broader philosophical assumptions is needed and should be identified by the researcher. Second, the participants need to have experienced the phenomenon so the researcher can fashion a prevalent understanding. Third, the researcher also needs to resolve the way in which his or her personal understanding is brought forward in the study.

## **Research Design**

This research study seeks to identify best practices by librarians in the development and implementation of STEAM initiatives in public libraries. In social science research, typical analysis includes individuals, groups, and social organizations. In order to analyze the data, a unit of analysis must be determined. The unit analysis, as defined by Trochim, Donnelly, and Arora (2015), is the *who* or *why* of the study and can be an individual student, group, or program.

**Analysis unit.** The unit of analysis for this study is a librarian in the public library. This librarian must have experience in the development, implementation, and promotion of informal learning activities described as STEAM. The librarian also needs to have a prerequisite understanding of science, technology, engineering and math programs in a community library.

**Population.** The study seeks librarians who offer specialized programs that encourage interest in the sciences such as makerspaces, coding classes, and STEAM after-school programs clubs. As such, the population for this study will be composed of librarians who have promoted STEAM programs, presented at conferences on the topic of STEAM programs in the public library, published in journals on the topic of STEAM, or are noted in publications as survey participants in studies that were made public. Ultimately, the participants will have provided educational opportunities in the area of STEAM learning in a public library setting.

**Sample size.** Sampling, as it relates to this study, involves the selection of the individuals to be studied. The sample will purposefully include only those with particular experience with STEAM initiatives in a public library setting. Creswell (1998) asserted that the qualitative size should be large enough to obtain feedback for most or all perceptions, which leads to saturation. Moreover, Glaser and Strauss (1967) recommended the concept of saturation, whereas Creswell (1998) also suggested that there are no set rules on the sample size. However, Creswell recommended 5–25 participants, with some consideration of time allotted, research objectives, and the availability of resources. This study will utilize a sampling size of 15 participants who have thoroughly met the criteria through purposive sampling and maximum variation.

**Purposive sampling.** According to Patton (2002), purposive sampling is a practice that is widely accepted in qualitative research and one that allows for the selection of participants through a method of maximum variation. This qualitative research study employed purposive sampling, allowing for maximum variation in the selection of participants that will provide the knowledge, experience, and availability of the information proposed. Bernard (2002) and Spradley (1979) also noted the importance of availability and the willingness to participate, while Patton (2015) concluded that the qualitative research method of purposive sampling intends to achieve a depth of understanding so as to saturate the information until no new substantive information is acquired. It places an emphasis on knowledge gained as a representation of the population from which the sample was drawn. Therefore, this method is most apropos for this study, as purposeful sampling seeks to distinguish the best practices of the participants who have actively demonstrated interest in the phenomena of STEAM in public libraries.



**Participation selection: Sampling frame to create the master list.** The process for selecting participants in this study began with the development of a master list. The master list was derived from a series of Internet searches utilizing Google’s search engine. Holmes (2006) asserted that Google is an approach to finding information across the worldwide web. The following steps led to a subset of articles on STEAM efforts in public libraries, which included authors and names of library systems to help yield contact information for the master list:

1. Type “google.com” in a search engine once a browser is open.
2. Several thematic headings in the study were used to access articles relating to STEAM in public libraries as keyword searches. The variations are:
  - a. “STEM/STEAM in libraries”
  - b. “STEM/STEAM in public libraries”
  - c. “STEM/STEAM + Library Activities”
  - d. “informal learning in libraries”
  - e. “informal learning in public libraries”
  - f. “technology programs in libraries”
  - g. “technology programs in public libraries”
  - h. STEM/STEAM and Makerspaces in public libraries
3. Each search yielded published articles noting participating libraries, researchers, and librarians in each article. The researcher selected appropriate authoritative articles from the first two pages of the generated search engine results, until the search yielded a sufficient number of prospective participants:
  - a. Each library in the United States has a website that provides the name of the library, its address, email address, and phone number.

- b. Articles. Each article provided the name of the participants (librarians) in the study as well as the name of the libraries hosting the STEAM program.
- c. Additional searches. If the search did not yield the publicly available names and contacts of potential participants to include in the master list, the researcher reviewed the next two available pages for each keyword search.

This process was repeated until a master list is created.

4. Based on results, a database was created to house the publicly available names and contact information of each person listed in the articles and their relevant experiences in the promotion of STEAM programs in a public library setting.
5. The database was created with columns to delineate participants who met the criteria for inclusion.
6. A set of criteria for inclusion and exclusion was used to identify and create a sample of a final list of 15 potential participants for the study.

***Criteria of inclusion.*** Participants for the study must meet the following criteria for inclusion to participate in the study:

- have demonstrated the need for STEAM programs through implementation of a series of programs over the course of a several months,
- have some experience with pathways for partnerships, grants, and collaborative efforts with experts in the field of STEAM, and/or
- exhibited a noted presence in the field through various publications.

***Criteria of exclusion.*** In order to gather the most effective the pool of data for further scrutiny, participants who do not meet the following two requirements were excluded from the study:

- Librarians of libraries that have programs led and developed by teens under 15 years.
- Librarians of libraries with programs that did not demonstrate longevity.

***Purposive sampling maximum variation.*** To ensure an information-rich study, participants were recruited using a purposive sampling applying a maximum variation. According to Creswell (2003), maximum variation is a method that assists the researcher in identifying criteria in advance that distinguish participants, allows documentation of diverse variations, and ascertains significant patterns in the study. This method is appropriate for this study because it discovers the unique best practices of persons involved in informal learning and STEAM in the public library who have experienced the same phenomenon. Purposive sampling of a total of 15 participants will be needed to ensure that the maximum variation includes (a) librarians or STEAM professionals, (b) demonstrated involvement with STEAM programming efforts, (c) experience with networking, and (d) varied experience.

### **Protection of Human Subjects**

The study began with the researcher processing who needs to be contacted to determine availability for a conversation (Richards & Morse, 2013). The voluntary list of participants was identified noting the involvement of human subjects and the need for study review and approval by the Pepperdine IRB. Therefore, “the Researcher should not expose research subjects to unnecessary physical or psychological harm” (Leedy & Ormrod, 2005, p. 101).

The main goal of Pepperdine University and the Graduate and Professional School’s IRB process is to protect human subjects involved in the study. To that end, noting the involvement of human subjects, guidelines are to be followed and are mandated by the United States Department of Health and Human Services (Leedy & Ormond, 2005, p. 101). Institutional review boards monitor this process before any person is approached as a potential participant in a study. As

deemed by Pepperdine University and its Institutional Review Board, the following details are noted: (a) participants have the right to voluntarily withdraw participation in the study at any given time, (b) participants are informed prior to participation of the fundamental reasons for the study and the process of data collection, (c) participants are assured of the confidentiality of the study, (d) participants are informed of any potential risk factors involved in the study, (e) participants are provided with potential benefits of the study, and (f) the participants as well as the investigator solidify the conditions of the agreement and that all information has been provided with signed consent (Creswell, 2003).

### **Recruitment Process**

Once the master list has been developed through a continuous process of searches yielding 15 potential participants until there are 15 persons that have agreed to the parameters set and willingness to be interviewed. Each prospective participant will then be reviewed based on the previous stated factors for inclusion narrowing the results ensuring a maximum variation. The prospective participants will then be sent an email introducing the interviewer, the study as well the research questions. The potential participant will then be contacted via phone verifying their interest and consent to participate and discussion of a possible interview via ZOOM, a video conference or a face to face interview.

### **Data Collection**

The data collection process began with an e-mail communication during working hours to the librarians' respective library e-mail accounts. All potential participants received an explanatory document via e-mail detailing purpose and the prerequisite requirements of the study. When a potential participant responded, further information was relayed via an e-mail concerning the reasons for the study, the process for data collection, the confidentiality

statement, benefits of the study, and consent forms for participation. A copy of the nine open-ended questions will be sent for review. A phone call was made one week later to further clarify any questions. The phone call was an opportunity to answer any questions concerning the process, such as an explanation of the process in its entirety, duration of the participation, voluntary participation, confidentiality, copyright, conflict of interest, remuneration, anonymity, and contact information for the questions. If the potential participant agreed to take part in the study, the semi-structured 45–60-minute interview will be scheduled at the discretion of the participant in their perspective office spaces located in various organizations throughout the U.S. At that point, the participant acknowledged having read the documents and chose a convenient time and location for the interview. Once participation was solidified with a returned, signed consent form, the signed documents were sent to the participant via e-mail prior to the scheduled interview. If the documents did not arrive prior to the interview, the researcher provided additional forms to be signed prior to the interview. The process in its entirety was repeated with each participant.

### **Interview Techniques**

According to Creswell (2007), rich data can be acquired in various ways in the qualitative investigative process, implying the proper construction of research questions and the analysis of the interview data. Creswell (2005) stated that “the intent is not to generalize to a population but to develop an in-depth investigation of a central phenomenon” (p. 203). The process as it relates to this study mandates gathering information from persons who are “information rich”; therefore, the interview structure lends itself to a semi-structured process that gives participants ample time and scope to express their views and allows the researcher time to react to ideas that may emerge from the interview (Nohl, 2010). The semi-structured interview also allows for an expression of

experience in narrative form (Nohl, 2010); it allows for the free expression of ideas without minimizing the researcher's attitudes and previous findings (Creswell, 2005). This semi-structured interview is structured to explore different topics related to a phenomenon while simultaneously providing an outlet for the extrapolation of new ideas. The versatility of the semi-structured method lends itself to appropriately addressing the topic of this study—the intersection of public libraries and the STEAM movement as an informal learning initiative. The arrangement of questions in the semi-structured approach yields multidimensional streams of data through the use of open-ended questions. This process leads to the opportunity for a more theoretical inquiry as the structure allows for further investigation of the lived experiences or phenomena (Galletta, 2012).

### **Interview Protocol**

The interview is the most common practice for gathering data in a qualitative research process (Creswell, 2007; Marshall & Rossman, 2016). Typically, the interviewer asks the same questions of each participant using one of three methodologies as asserted by Creswell (2003) as unstructured, semi-structured., or structured. Interviews that embrace conversations between the investigator and participants are unstructured, allowing the maximum flexibility in collecting data discovery of information during the discourse (Ritchie, Lewis, Nicholls, & Ormston, 2013). Unstructured interviews do not have any preconceived theories and generally provide very little guidance (Leedy & Ormrod, 2005). The use of verbally administered questions that are predetermined without scope or variation and do not give way to further questions are structured interviews. When several key questions are used to define the scope and area to be explored, semi-structured process allows for open-ended questions in pursuit of articular parameters, and allows for detailed responses of a subject matter.

This qualitative research paper will utilize a semi-structured process. The study will bring forward new, innovative ideas that have yet to be captured in the literature. Roulston, deMarrais, and Lewis (2003) examined the challenges of the interview process, and in concert with Creswell (1998), explored potential unexpected behavior such as emotional outbursts and the technique of saying very little, as the process can be lengthy. The strategy chosen for this study was to use an icebreaker question as recommended by Creswell (2013) to begin the dialogue and create a relaxing environment in order to yield the best possible results.

**The relationship between research and interview questions.** The qualitative research process for conducting interviews examines the relationship between the interviewer and the interviewee (Kvale & Brinkman, 2009). The process for developing the interview protocol after a careful review of conditions that foster quality interviews involves access to and selection of participants (Rubin & Rubin, 2012). The investigator developed an interview protocol of nine open-ended questions that were formulated from the four research questions and further substantiated by the literature review. The process for selecting the research questions involved assiduous concern for the design of the interview protocol, ensuring a comprehensive coverage of the subject matter. The strategy used to construct the interview questions was designed to gain the greatest results related to the lived experience and the meaning derived from the interview questions. The use of open-ended questions gave the interviewees the opportunity to further express their experiences as it related to a relatively new phenomenon in the public library with the guidance of a research question. Table 1 details the relationship of the research questions with their corresponding interview questions.

Table 1  
*Research Questions and Corresponding Interview Questions*

Research Questions	Corresponding Interview Questions
RQ 1. How do public libraries measure success in the promotion of informal learning programs related to STEAM?	IQ 1. What were your strategies for creating and implementing STEAM programs? IQ 2. How did you decide on the structure of your STEAM program? IQ 3. How did you overcome resistance or opposition to your plan? IQ 4. How do you define a STEAM program in your library?
RQ 2. What are the challenges that public libraries face related to the promotion of informal learning programs focused on STEAM?	IQ 5. What challenges did you face in the planning phase of the implementation? IQ 6. How did you deal with or overcome the challenge?
RQ 3. What Strategies and practices have been implemented in public libraries to promote informal learning opportunities related to STEAM?	IQ 7. How did you define success for the STEAM implementation? IQ 8. What were the expected outcomes of the program? IQ 9. How did you measure and track your success?
RQ 4. Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?	IQ 10. What recommendations would you make for public libraries in the implementation process? IQ 11. What advice would you give to other public libraries who are considering implementing STEAM programs? IQ 12. What would you like to have known before you started the STEAM initiative? IQ 13. Is there anything else that you would like to share about your experience that would be relevant to the study? IQ 14. If you could start over, what would you do differently? IQ 15. Have I left anything out?

*Note.* The table identifies four research questions and corresponding 15 interview questions. Interview questions were reviewed by a panel of two peer reviewers and expert reviewers.



**Reliability and validity of the study.** The foundation of qualitative research is based on data that is subjective, interpretive, and contextual, which sets the stage for questions and scrutiny. Therefore, Best and Kahn (2006) asserted a critical need for the researcher to ensure reliability and validity of the research findings. According to Kirk and Miller (1986), the findings should be believable, consistent, applicable, and credible. Reliability refers to the ability of the findings to be repeated, showing consistency within the research. Validity reflects the accuracy and correctness of the findings and the degree to which the instrument produces consistent results. Kirk and Miller (1986) reviewed how we judge reliability and validity, using these four aspects:

- **Credibility**—In many instances, credibility is called internal validity and refers to the believability and trustworthiness of the findings. Credibility/internal validity examines the richness of data more so than the quantity, using triangulation for cross checking information from various perspectives.
- **Transferability**—Commonly referred to as external validity, transferability allows for the transfer of the context, comparing the legitimacy of the findings across groups. Therefore, the results are generalizable and can be used in different populations, situations, and settings.
- **Dependability**—Also known as reliability, dependability is the ability of the study to be replicated with identical results. Dependability also defines legitimacy of the qualitative research method, as other researchers may want to replicate the study.
- **Confirmability**—Confirmability substantiates how well the research is supported by the data collected. Confirmability describes the level of objectivity the researcher used in evaluating the results (Lincoln & Guba, 1985; Cohen & Crabtree, 2006).

***Prima-facie and content validity.*** According to qualitative pedagogy and the protocols for data collection, the first step is to develop the data collection instrument. The instrument consists of the research questions that align with the literature on the topic matter. According to Rubin & Rubin (2012) and the interview refinement protocol, a four-phase process includes: (a) ensuring the interview questions align with the research questions, (b) ensuring the questions construct an inquiry-based conversation, (c) receiving feedback on the interview questions, and (d) piloting the interview protocol.

***Peer-review validity.*** Peer-review validity, according to Creswell (2013), involves obtaining feedback from multiple sources, which increases alignment with participants. The peer review validity permits the researcher select reviewers outside of the process but having some expertise of the subject matter. This step in the validity process relies on outside experts to examine the quality of the instrument development process to ensure data collection that is effective in its purpose. The investigator began by constructing a table that situates each research question with each interview question (see Table 2).

The next step requires the attainment of two subject matter experts to examine and scrutinize the peer review process for any needed improvements. The search resulted in two doctoral students who agreed to participate, both of whom have acquired over 20 years of experience working in government organizations that serve the public. Their experience included the promotion and development of services for the general public, and they offered their combined knowledge of the research process as doctoral students. They provided the subject matter expertise based on their experience as practitioners and their understanding of research methods. The peer reviewers were provided copies of the interview and research questions and research question table and were asked to follow these guidelines:

Table 2

*Research Questions and Corresponding Interview Questions with Peer Reviewers*

Research Questions	Corresponding Interview Questions
RQ 1. How do public libraries measure success in the promotion of informal learning programs related to STEAM?	<p>IQ 1: What were your strategies for creating and implementing STEAM programs?</p> <p>Accept Decline Suggestions</p> <p>IQ 2: How did you decide on the structure of your STEAM program?</p> <p>Accept Decline Suggestions</p> <p>IQ 3: How did you overcome resistance or opposition to your plan?</p> <p>Accept Decline Suggestions</p> <p>IQ 4: How do you define a STEAM program in your library?</p> <p>Accept Decline Suggestions</p>
RQ 2. What are the challenges that public libraries face related to the promotion of informal learning programs focused on STEAM?	<p>IQ 5: What challenges did you face in the planning phase of the implementation?</p> <p>Accept Decline Suggestions</p> <p>IQ 6: How did you deal with or overcome the challenge?</p> <p>Accept Decline Suggestions</p>

(continued)

Research Questions	Corresponding Interview Questions
<p>RQ 3. What strategies and practices have been implemented in public libraries to promote informal learning opportunities related to STEAM?</p>	<p>IQ 7: How did you define success for the STEAM implementation?</p> <p>Accept Decline Suggestions</p> <p>IQ 8: What were the expected outcomes of the program?</p> <p>Accept Decline Suggestions</p> <p>IQ 9: How did you measure and track your success?</p> <p>Accept Decline Suggestions</p>
<p>RQ 4. Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?</p>	<p>IQ 10: What recommendations would you make for public libraries in the implementation process?</p> <p>Accept Decline Suggestions</p> <p>IQ 11: What advice would you give to other public libraries who are considering implementing STEAM programs?</p> <p>Accept Decline Suggestions</p> <p>IQ 12: What would you like to have known before you started the STEAM initiative?</p> <p>Accept Decline Suggestions</p>

(continued)

Research Questions	Corresponding Interview Questions
	<p data-bbox="488 268 1357 338">IQ 13: Is there anything else that you would like to share about your experience that would be relevant to the study?</p> <p data-bbox="488 380 643 485">Accept Decline Suggestions</p> <p data-bbox="488 527 1276 558">IQ 14: If you could start over, what would you do differently?</p> <p data-bbox="488 600 643 705">Accept Decline Suggestions</p> <p data-bbox="488 747 899 779">IQ 15: Have I left anything out?</p> <p data-bbox="488 821 643 926">Accept Decline Suggestions</p>

*Note.* The table identifies four research questions and corresponding interview questions. Interview questions were reviewed by a panel of two peer reviewers and expert reviewers.

- Assess the relevance of the research questions.
- Review the interview questions and evaluate whether the questions address the research questions.
- Employ guidance with suggestions for fitting the interview questions with the research questions.
- Make recommendations for enhanced questions.

Each expert reviewed the interview questions, and as a result, three suggestions were made for revision:

- Revised IQ 1. What are the strategies you implemented in the creation of STEAM programs?

- Original IQ 14 should be deleted and replaced by IQ 12: What would you like to have known before you started the STEAM initiative?
- Delete original IQ 15 and replace it with IQ 13. Is there anything else that you would like to share about your experience that would be relevant to the study?

Table 3 shows the arrangement of interview questions that have been revised.

Table 3

*Research Questions and Corresponding Revised Interview Questions*

Research Questions	Corresponding Revised Interview Questions
RQ 1: What strategies and practices have been implemented in public libraries to promote informal learning opportunities related to STEAM?	<p>IQ 1: What were your strategies for creating and implementing STEAM programs?</p> <ul style="list-style-type: none"> <li>• How did you decide on the structure of your STEAM program?</li> <li>• How do you define a STEAM program in your library?</li> </ul>
RQ 2: What are the challenges that public libraries face related to the promotion of informal learning programs focused on STEAM?	<p>IQ 2: What challenges did you face in the planning phase of the implementation?</p> <ul style="list-style-type: none"> <li>• planning</li> <li>• design</li> <li>• implementation</li> <li>• post implementation</li> </ul> <p>IQ 3: How did you deal with or overcome the challenge in:</p> <ul style="list-style-type: none"> <li>• planning</li> <li>• design</li> <li>• implementation</li> <li>• post implementation</li> </ul> <p>IQ 4: How did you overcome resistance or opposition to your plan?</p>
RQ 3: How do public libraries measure success in the promotion of informal learning programs related to STEAM?	<p>IQ 5: How did you define success for the STEAM implementation?</p> <p>IQ 6: How did you measure and track your success?</p>

(continued)

Research Questions	Corresponding Revised Interview Questions
RQ 4: Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?	<p>IQ 7: What recommendations would you make for public libraries in the implementation process?</p> <p>IQ 8: If you could start over, what would you do differently?</p> <p>IQ 9: Is there anything else you would like to share?</p>

*Note.* The table identifies four research questions and corresponding interview questions with revisions based on feedback from peer reviewers and an expert reviewer. Subsequent changes were made to the order and phrasing of questions within the interview protocol.

**Expert review validity.** The final step involved establishing validation from the expert review. This step provides some assurance of a final decision in the event that consensus is not established in during the peer review process. The dissertation committee becomes the mitigating decision maker in the situation when a peer reviewer's remarks or comments are not in agreement with the researcher. The dissertation committee then examines the suggestions and comes to consensus on the inclusion of said edits or suggestions. The expert review was conducted and the following revisions have been made to the interview questions:

- Original IQ 1: What were your strategies for creating and implementing STEAM programs?
- Revised IQ 1: What are the strategies you implemented in the creation of STEAM programs?
- Original IQ 14: If you could start over, what would you do differently?
- Deleted and replaced by IQ 12: What would you like to have known before you started the STEAM initiative?
- Original IQ 15: Have I left anything out?

- Deleted and replaced by IQ 13: Is there anything else that you would like to share about your experience that would be relevant to the study?

**Reliability of the study.** Reliability in qualitative research alludes to the replicability of the process and the results. The essence of the process in qualitative research relies on the consistency of data (Carcary, 2009). Kirk and Miller (1986) asserted the need of for both internal and external validity in determining the credibility of the research instrument. The transferability of the data collection, findings, and results across groups provides assurance in the reliability of the instrument when others are able to discover the same phenomena (leCompte & Goetz, 1982).

The researcher also performed two pilot interviews to test for additional validation of the interview questions. These participants met the established criteria for participation. The participants were asked all questions and asked to provide feedback on the tool. The instrument was further modified and changes were incorporated in the final interview tool. The researcher, employing both external and internal reliability in the research process, sought to optimize the reliability of the data collection instrument (Creswell, 2013).

### **Statement of Personal Bias**

Creswell (2009) stated the need for a disclosure of personal bias in the qualitative research process to provide the perspective from which the data was scrutinized for the study.

The researcher discloses the following personal biases to the research process:

- Twenty-five years of combined experience as a public librarian and international academic librarian. The last 10 years included leadership and project management with an emphasis on service to youth and science education.
- An undergraduate degree in Spanish with a minor in education, a master's degree in library and information science, and international experience that has molded the way



she views and analyzes public service and lifelong learning initiatives in public libraries.

- Experience with the promotion of STEAM programs in public libraries.

### **Epoche and Bracketing**

According to Chamberlain (cited in Sanders, 1982), epoche is the process of temporarily suspending the researcher's beliefs, preconceptions, and assumptions about the phenomena in order to achieve pure clarity on the vision of the research. The process is also referred to as bracketing (Creswell, 2013) or setting aside biases in order to optimize the experiences of the participants, which include:

- The researcher identifies all potential biases, experiences, and knowledge that are a part of the ethical awareness when research is congruent to personal values (Miles & Huberman, 1994).
- The researcher also notes any biases that arise during the research process and the reporting of such to inform the reader of the biases that come forth in the interpretation of findings (Creswell, 2013).

In this study, the researcher examined and noted all experiences, biases, and knowledge related to the subject matter of the paper. Second, the researcher developed a journal to also note any biases that may arise during the interview process. Last, biases were identified and bracketed for the readers' review of the study's findings, as recommended by Creswell (2013).

### **Data Analysis**

Marshall and Rossman (2016) described data analysis as the process of bringing order, structure, and meaning to the interview data collected. The process of data analysis commences with the transcription of the interviews. The interview data is coded and analyzed as described by

Schwandt (2007) to make sense of the information gathered through general statements among categories of data. The data is transcribed, analyzed, and coded to examine similar themes, ideas, characteristics, and experiences. The researcher will also maintain a journal documenting any insights that develop during the process (Creswell, 2013).

**Other coders.** The researcher then obtained other coders to assess themes and discuss data codes with the goal of finding consensus on the common themes and data. When the consensus met the co-reviewers' challenges, the data analysis was forwarded to an expert review for final determination.

**Interrater reliability and validity.** In an effort to show reliability and validity the investigator will begin by taking the first three transcripts and code accordingly. Thereafter, the investigator will share the themed categories with two doctoral students to provide validity of the questions and process in order to arrive at a consensus for the agree methodology for coding and thereafter code the remainder of the interviews following the same procedure.

To ensure the aforementioned process for clarity of the data analysis process, Creswell (2013) recommended six steps for phenomenological analysis:

1. Data organization—All interviews are recorded on an MP3 device. Each interview is listened to and the spoken word is put in written format in a process described as transcription. The researcher develops a structure for the data captured in the interview process and incorporates the findings in an Excel document.
2. Reading and annotating—The transcribed data is then reviewed and memoed. The researcher develops codes representing ideas and concepts formulated from the initial codes.

3. Describing the data—The researcher aggregates data into categories or themes as defined by Creswell (2013). Creswell's recommendation was to establish 25–30 codes that yield five to six common themes that assist with unifying the data.
4. Classifying the data—The researcher develops sub-themes that present themselves in the description of the data. The researcher then develops statements that create meaningful units of data.
5. Interpreting—This step of the process involves textural descriptions and structural descriptions that capture what happened and how it happened (Moustakas, 1995) The researcher notes what happens by coding information in subsets or themes that are derived from the collected data.
6. Representing and visualizing the data—The final step involves completing the data analysis. Once unanimity is reached by all, a summary is developed, with a report of the findings in Chapter 4.

## **Chapter Summary**

Chapter 3 takes an in-depth look at the research design and methodology used in the best practices of the qualitative phenomenological study on the intersection of the public library and STEAM. The restatement of the research questions and explanation for the use of a phenomenological approach is discussed. The process further delineated by Creswell's (2013) example establishes the unit of analysis, population, and sample. In order to select participants for the study as well as define the sample, inclusion and exclusion were discussed. The IRB process is an important step as it ensures the safety and confidentiality of participants. An interview guide as established by Patton (2015) stated that the interview protocol guides the same basic line of inquiry with each interviewee. The data collection tool then validates whether

the interview questions are related to the research questions and how interrater reliability and validity was employed in the process. The chapter also presented discourse about the interview process that allows for effective interviews. The final section outlined how the data is analyzed by the researcher, detailing the validity and reliability of the methodology, including an explanation of the method for reporting the results in Chapter 4.

## **Chapter 4. Findings**

Today's public libraries worldwide are collectively evaluating future usage and reshaping the library's use beyond the book without negating the core element of literacy and learning held by the founding fathers of libraries. The public library serves as a need for many; however, for some the influence is one of economics and for others sentimental thoughts of days past that include functions and services that have been replaced with technological efficiencies (Brogan, 2015). Tomorrow's library embraces a service model that includes the library as a place in the community with an emphasis not only on the reader and persons who are tech savvy, but also the use of space planning for those seeking a place for retreat and entertainment (Dewe, 2017). In addition, 97% of all public libraries have embarked on providing programs that have either been developed in support of science education within the mandate of other education institutions or district initiatives, as well as grassroots efforts lead by STEAM leaders who are moved by the urgency to support the needed enhancements nationwide in the area of math and science in their respective communities (ALA, 2014).

The purpose of this study was to explore best practices for the implementation of STEAM programs in a public library system and advancing the informal learning opportunities within public spaces. To accomplish this task, this study sought to answer the following four research questions:

- What strategies and practices have been implemented in public libraries that focus on informal learning opportunities related to STEAM?
- What are the challenges that public libraries face as they relate to the implementation and development of informal learning programs focused on STEAM?

- How do public libraries measure success within informal learning programs related to STEAM?
- What lessons have been learned in the development of informal learning spaces focused on STEAM in the public library?

To answer these four questions, an interview protocol composed of nine open-ended questions was developed, with each interview question directly informing a specific research question. The interview protocol was validated through an interrater reliability and validity procedure. Through the use of the interrater reliability and validity procedure, the following nine research questions were approved and used to interview participants for this study:

1. What were your strategies for creating and implementing STEAM programs?

Follow-up questions: How did you decide on the structure of your STEAM program?

How do you define a STEAM program in your library?

2. What challenges did you face in the planning phase of the implementation?

Follow-up question: What challenges did you face in the design, implementation, and post-implementation?

3. How did you deal with or overcome the challenge in planning, design, implementation, and post-implementation?

4. How did you overcome resistance or opposition to your plan?

5. How did you define success for the STEAM implementation?

6. How did you measure and track your success?

7. What recommendations would you make for public libraries in the implementation process?

8. If you could start over, what would you do differently?
9. Is there anything else you would like to share?

Interview participants were asked to provide responses to the nine questions and elaborate by providing as much information as they felt comfortable. The responses to the nine interview questions collectively provided an in-depth understanding of the best practices that public libraries and persons responsible for STEAM programming employed to make the programs successful. This chapter provides a description of the data analysis process and the interrater review process used to validate the data analysis process. In addition, this chapter reports the findings from the analysis of the data collected from the nine interview questions.

A total of 11 participants were interviewed as a result of reaching saturation in the research for this study. Participants for the study ranged from ages 18–64. Of the 11 participants, three (27%) were male and eight (72%) were female. Participants included three managers of a systemwide STEAM initiatives, two with titles that are not traditional titles for librarians but address the needs of persons with specialized interests; the remainder carried the title of librarian. Three participants are former teachers with back grounds in science, education, and learning. All participants have a sincere interest in learning initiatives. Six participants have master degrees in library science and one participant has a bachelor degree in information science (see Table 4).

Table 4  
*Participants' Statistics*

Participants	Degree Earned	Gender	Interview Date
P1	BS Science/MLS Science	Female	02/07/2018
P2	BS Information Science	Male	02/13/2018
P3	MLS Science	Female	02/26/2018
P4	MLS Science	Female	02/26/2018
P5	Education/MLS Library Science	Female	03/07/2018
P6	BS Biology/MLS Library Science	Female	03/07/2018
P7	MLS Library Science	Female	03/08/2018
P8	MLS Library Science	Female	03/12/2018
P9	Former Teacher	Male	03/13/2018
P10	MLS Library Science	Female	03/14/2018
P11	Former Teacher/MLS Science	Male	03/22/2018

### **Data Collection**

Data collection for the 11 interviews began with a series of Internet searches utilizing Google's search engine and eight keyword searches, using variations of the following terms:

- "STEM/STEAM in libraries,"
- "STEM/STEAM in public libraries,"
- "STEM/STEAM + Library Activities,"
- "informal learning in libraries,"
- "informal learning in public libraries,"
- "technology programs in libraries,"
- "technology programs in public libraries,"
- "STEM/STEAM and Makerspaces in public libraries."

The search was first filtered to identify libraries and persons who have developed STEAM programs. Next, the list was sorted to ensure that potential participants met all the criteria for



inclusion. The criteria for inclusion were verified by visiting the website for each library and reviewing the scope of programs offered in STEAM. After applying all the actors of inclusion, an initial list of 89 participants was obtained and narrowed to 15 participants, ensuring maximum variation. Data collection began in late January 2018 after obtaining full IRB approval in early January 2018 from Pepperdine University. Data collecting was conducted during February and through the third week of March, utilizing the approved IRB recruitment script. During the last week of January, a total of 20 recruitment e-mails were sent. The first batch of recruitment e-mails yielded two interviews, five responses of no interest, and 14 non-responses. During the second week of February, a second batch of 20 e-mails were sent. The second batch of recruitment e-mails yielded one interview. To further recruit, the list was expanded to include a total of 89 participants who met the criteria for inclusion. With the expanded list, participant recruitment continued for the next four weeks by sending an average of 20 recruitment e-mails per week. A total of 89 interview requests were sent during a six-week period, yielding a total of 11 completed interviews.

Participants who agreed to be interviewed were provided a copy of the informed consent form and interview questions prior to the initial meeting. All participants were provided with the opportunity to ask questions prior to collecting the signed informed consent form. In addition, participants were provided the option of anonymity. This option was provided in order to obtain as much candor as possible during the interview but none of the interviews took more than an hour to complete. The longest interview took 48 minutes, and the shortest interview took 24 minutes. All interviews were recorded after obtaining consent from participants.

## **Data Analysis**

Coding, as defined by Creswell (2013), is the process of aggregating data into small categories or themes that arise from data during the interview process. The data was captured by audio recordings and handwritten notes taken during the interview. Next, the researcher listened to the audio recording three times to memo and bracket all perceived biases to ensure that the researcher's personal biases did not influence the data analysis process. According to Creswell (2000), it is necessary for a researcher to state his or her biases when conducting a research project so that the reader understands the perspectives from which the data was analyzed and coded for key phrases, viewpoints, or responses that provide a descriptive response to the interview questions. This process was repeated three times for all questions. The process was utilized to solidify the coding of key phrases, viewpoints, or responses. The next step involved clustering the codes into common themes, then sorting and ranking the themes by highest to lowest frequency. Theme names were derived by utilizing descriptive verbiage included in the transcripts. The next step in the data analysis process was validating the data utilizing the interrater review process.

## **Interrater Review Process**

The interrater process was conducted by two doctoral students enrolled in the Doctor of Education in Organizational Leadership program at Pepperdine University. Both doctoral students have work experience in public organizations and have experience with similar research technology. In addition, both doctoral students have training in qualitative research methods and data analysis. The reviewers were provided copies of all the researcher's grids that contained the coded key phrases, viewpoints, or responses and their corresponding theme grouping. In

addition, the reviewers were provided with copies of the research questions to assist with the review of the data analysis. The reviewers were asked to do the following:

- Review and provide feedback on all key phrases, viewpoints, or responses for proper thematic designation.
- Review and provide feedback on the thematic name designation.

The interrater review process yielded 10 edits to the data analysis. A discussion regarding all edits was conducted as a group and, based on the feedback, consensus was reached and three edits were made (see Table 5).

Table 5  
*Interrater Review*

Interview Questions	Items	Suggestion	Action taken
1	structure in fluid	move from theme knowledge creation to theme dynamic developments	move to dynamic development
1	personal time management	broaden to include other concerns about time	changed theme to time management
2	acquisition of staff	broaden to include other staff concerns	changes theme to staff issues

## Data Display

The data were presented and organized by research question and corresponding interview questions. Key phrases, viewpoints, or responses were grouped and sorted into common themes. Frequency charts were used to summarize and present data visually. In addition, a description of each theme is provided and corroborated with a participant quote found in the transcribed data. To preserve the integrity of the data and remove subjectivity of interpretation, statements and excerpts were reported verbatim. As such, it is important to note that excerpts may contain incomplete sentences. Notwithstanding, the researcher has made every effort to ensure that the

participant's intent is not miscommunicated. Participant quotes are reported using labels corresponding to their interview order, such as Participant 1 (P1), Participant 2 (P2), and so forth.

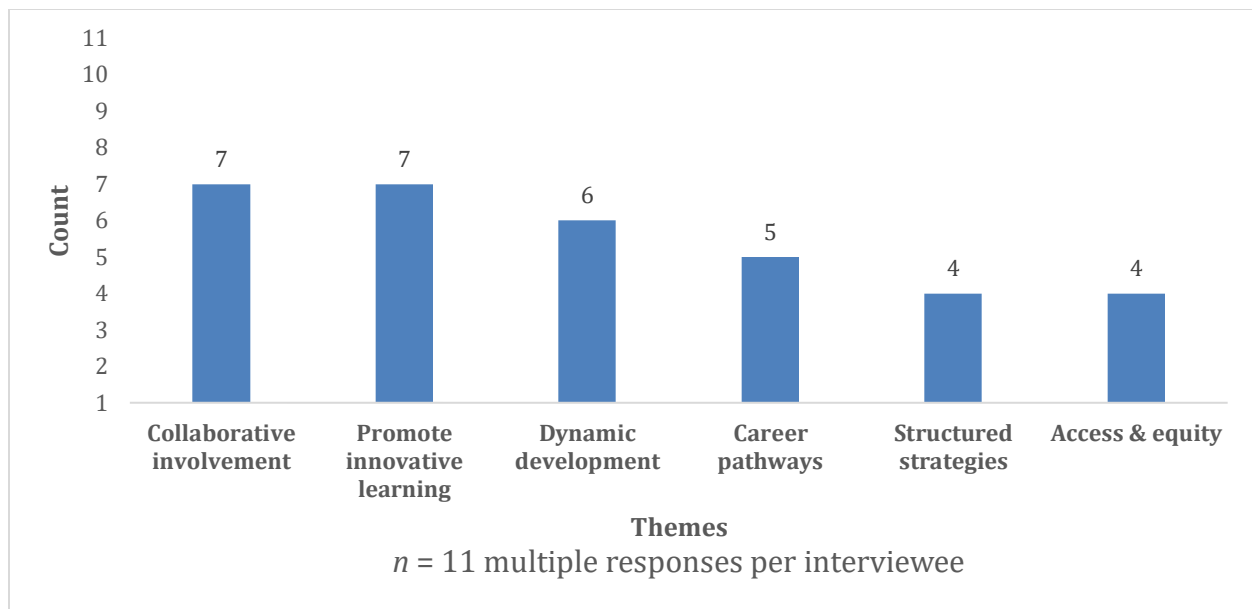
### **Research Question 1**

Research question 1 asked, "What were the strategies for creating and implementing STEAM programs?" Two interview questions were asked to the interview participant in order to provide an answer to RQ 1:

- How did you decide on the structure of your STEAM program?
- How do you define a STEAM program in your library?

The responses from all interview participants for the two interview questions were analyzed for common themes that informed the overall response to RQ 1.

**Interview question 1.** How did you decide on the structure of your STEAM program? Through the analysis of all responses to IQ 1, 65 elements involving structure were identified, which were grouped into six common themes: (a) access and equity, (b) career pathways, (c) collaborative implementation, (d) dynamic development, (e) promote innovative learning, and (f) structured strategies (see Figure 5).



*Figure 5.* Interview question 1: Coding results. In the discussion of strategies for creating and implementing STEAM programs, six themes emerged from responses to IQ 1. Data are presented in decreasing order of frequency. The numbers in each theme indicates the number of times a direct or indirect statement was made by an interview participant that fell into the respective theme category.

***Collaborative involvement.*** Collaborative involvement connotes that circumstances such as STEAM necessitate the consensus of actions and agreements shared by external and internal partners toward a mutual goal. Interview question 1 yielded collaborative involvement as a strategy for creating and implementing STEAM programs. Of the 65 phrases, viewpoints, or responses, seven (21%) responses to IQ 1 were directly or indirectly related to collaborative involvement. Items that were coded under this theme included a statement by P1, “gather suggestions from staff and experts.” In fact, P4 shared, “We collaborate and connect with community partners.”

***Promote innovative learning.*** The second strategy for creating and implementing STEAM programs was the promotion of innovative learning. Promoting innovative learning represents knowledge creation that is creative and provides meaning. Of the 64 phrases, viewpoints, or responses, seven (21%) responses to IQ 1 were directly or indirectly related to the

promotion of innovative learning. Items coded under this theme included a statement by P2, “My goal is to give youth the technology, the space and let them create your own future.”

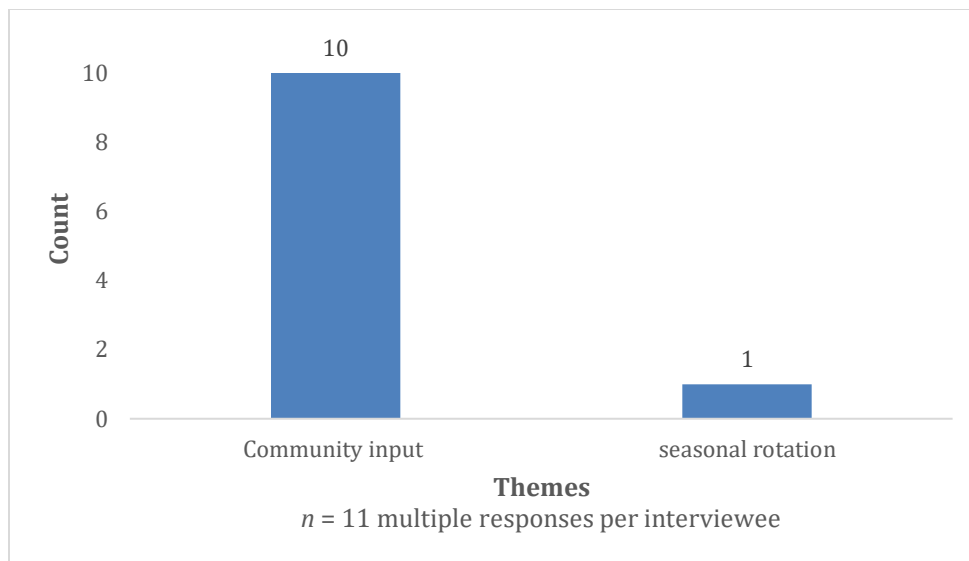
***Dynamic development.*** The third theme derived from the coding of strategic ideas on creating and implementing STEAM programs was dynamic development. Dynamic development happened in programs that were not static and continued to evolve in their development of STEAM implementation. Of the 65 phrases, viewpoints, or responses, six (18%) responses to IQ 1 were directly or indirectly related to dynamic development. Items coded under this theme included a guideline noted by P2, “We’re going to let you explore and figure out what you’re interested in.” P11 cited the library’s ability to “provide public access to a 3-D printer that has been used in the creation of a medical prototype.”

***Career pathways.*** The fourth theme derived from the coding was career pathways. Career pathways education programs in the public library that provide resources for and guidance to careers related to STEAM. Of the 65 phrases, viewpoints, or responses, five (15%) responses to IQ 1 were directly or indirectly related to career pathways. Items coded under this theme included this phrase by P3, “connecting kids to STEAM careers.” P8 noted that “the programs are designed to increase youths’ confidence in topics related to science.”

***Structured strategies.*** The fifth theme derived from the coding was structured strategies. Structured strategies are those traditional methods for creating and implementing programs which involve such elements as stated by P1 as “outlines, structures that are tested and are proven to work well and clearly communicates what’s next.” Of the 65 phrases, viewpoints, or responses, four (12%) responses to IQ 1 were directly or indirectly related to structured strategies.

***Access and equity.*** The sixth theme derived from the coding was access and equity. Access and equity is defined as the provision of learning environments that provide opportunities for diverse backgrounds. Interview question 1 yielded access and equity as a strategy for creating and implementing STEAM programs. Of the 65 phrases, viewpoints, or responses, four (12%) responses to IQ 1 were directly or indirectly related access and equity. Items coded under this theme included a phrase by P5: “providing access to kids and adults of varying abilities” and P3 described “strategies that equate to access and equity in education.”

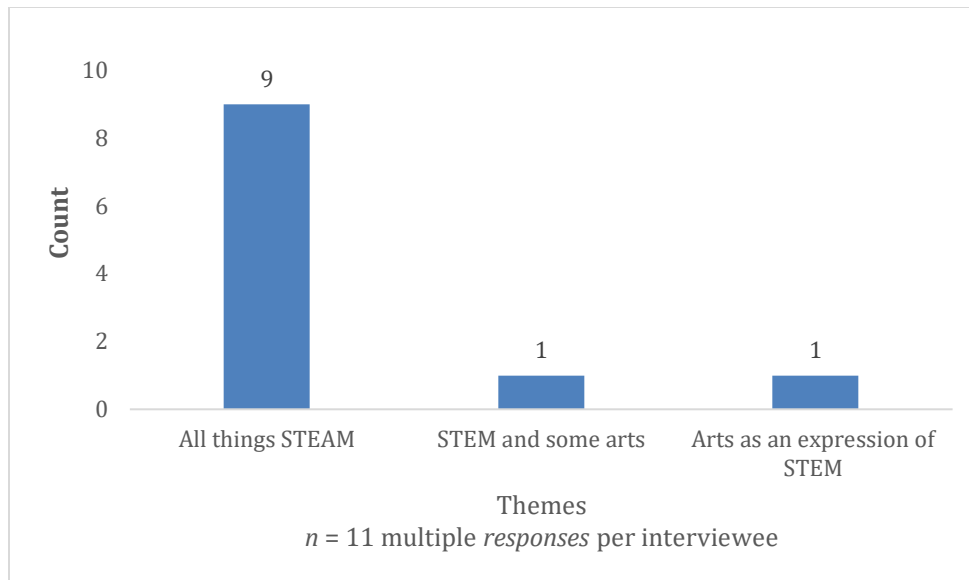
***First follow-up question to IQ 1.*** The first follow-up question asked, “How did you decide on the structure of your STEAM program?” Overwhelmingly, 90% (10) of the respondents viewed the need for community engagement as the overall component in deciding on the structure of the STEAM program. Secondly, 9% (one) participant explained the structure as seasonal established by the program leader. P11 indicated that “the structure was 100% community-led, with businesses, foundations, and individuals [telling] us what they wanted.” Similarly, 100% of respondents also saw the structure as a needed element, creating awareness of STEAM in the public library. P9 indicated that the challenge lies in learning as much as possible to offer programs that are a la carte (see Figure 6).



*Figure 6.. Interview question 1, follow-up question 1: Coding results.* In the discussion of strategies for creating and implementing STEAM programs, two themes emerged from the follow-up question “How did you decide on the structure of your STEAM program? Data are presented in decreasing order of frequency. The numbers in each theme indicates the number of times a direct or indirect statement was made by an interview participant that fell into the respective theme category.

***Second follow-up questions to IQ 1.*** The second follow-up question asked, “How do you define STEAM in your library?” The question yielded eighty-one percent (nine) of the participants defined STEAM as noted by P5: “anything that hits on science, technology, engineering, art and math.” Similarly, 9% (one) respondent also saw that art was a necessary component but perceived STEM to be dominant in program development and another 9% (one) spoke of art as the foundational platform for STEM. P11 stated, “Art is hands-on, interactive, and engaging in any of the five areas of STEAM,” and conversely, “everything about making and fabrication can be related to STEM” (see Figure 7).





*Figure 7.* Interview question 1, follow-up question 2: Coding results. In the discussion of strategies for creating and implementing STEAM programs, two themes emerged from the follow-up question “How do you define a STEAM program in your library? 1. Data are presented in decreasing order of frequency. The numbers in each theme indicates the number of times a direct or indirect statement was made by an interview participant that fell into the respective theme category.

**Summary of research question 1.** RQ 1 sought to identify the strategies and practices that have been implemented in public libraries to promote informal learning opportunities related to STEAM. There was one interview question (“What were your strategies for creating and implementing STEAM programs?”) and two follow-up questions (How did you decide on the structure of your STEAM program? How did you define a STEAM program in your library?) were used to inform RQ 1. A total of six themes were identified by analyzing key phrases, viewpoints, or responses to the interview and follow-up questions. The six themes were (a) collaborative involvement, (b) promote innovative learning, (c) dynamic development, (d) career pathways, (e) structured strategies, and (f) access and equity.

## Research Question 2

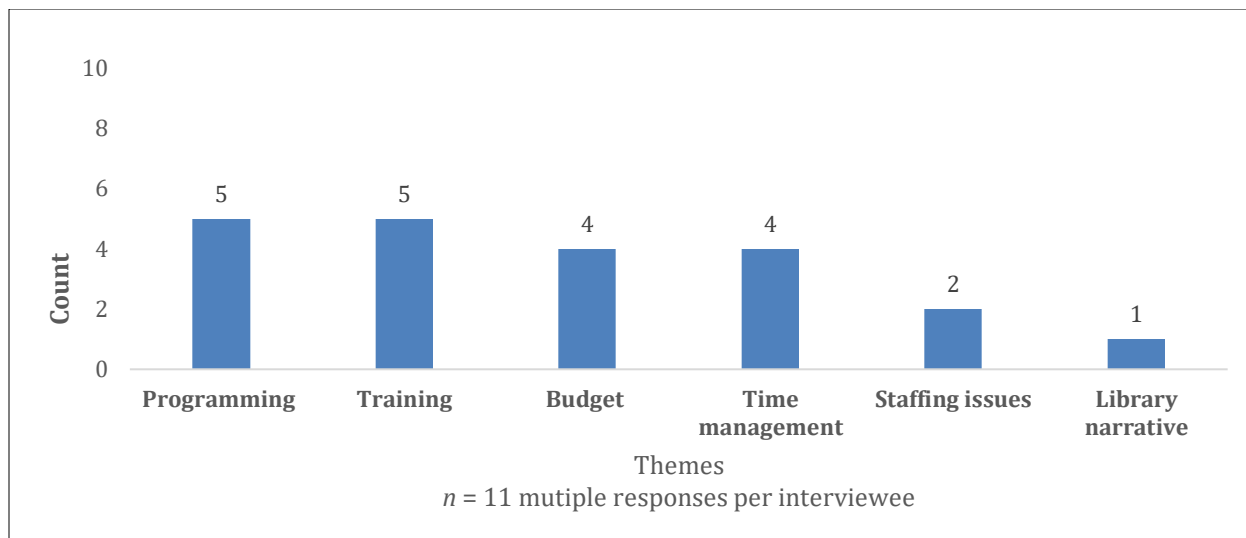
Research question 2 asked, “What are the challenges that public libraries face related to the promotion of informal learning programs focused on STEAM?” Three interview questions were asked of each participant in order to provide answers for RQ 2:

- IQ 2. What challenges did you face in the planning phase of the implementation?
- IQ 3. How did you deal with or overcome the challenges in in planning, design, implementation and post implementation?
- IQ 4. How did you overcome resistance or opposition to your plan?

The responses from all interview participants for the two interview questions were analyzed for common themes that informed the overall response to RQ 2.

**Interview question 2.** IQ 2 asked, “What challenges did you face in the planning phase of the implementation?” Through the analysis of all responses to IQ 2, a total of 50 key phrases, viewpoints, or responses related to the challenges faced in the planning phase of the STEAM implementation were identified. The key phrases, viewpoints, or responses were grouped into six common themes: (a) programming, (b) training, (c) staffing, (d) budgets, (e) time management, and (e) library narrative (see Figure 8).

***Programming.*** Programming ranked highest in frequency with 21 instances. Programming is defined as events centered around some aspect of the five areas of STEAM. Interview participants indicated that programming is a challenge in the implementation of STEAM. Of the 50 key phrases, viewpoints, or responses, five (23%) responses to IQ 2 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Programming involves offering courses that are culturally relevant, require evaluation and



*Figure 8.* Interview question 2: Coding results. In the discussion on challenges faced by the public library as related to the promotion of informal learning programs focused on STEAM, six themes emerged from responses to IQ 2. Data are presented in decreasing order of frequency. The numbers in each theme indicates the number of times a direct or indirect statement was made by an interview participant that fell into the respective theme category.

resources, connect with adolescents’ interests, and are shaped by branding and networking. P9 pondered, “How do you evaluate a drop-in program and measure the effort?”

**Training.** Training ranked the second highest in frequency with 10 instances. Training is defined as formal or informal methods for preparing staff to execute programs. Interview participants indicated that training is a challenge in the implementation phase of STEAM. Of the 50 key phrases, viewpoints, or responses, five (23%) responses to IQ 2 were directly or indirectly related to the challenges faced in the implementation phase of STEAM. Training includes acquiring the skills needed to instruct STEAM. P1 noted that “staff feel that they do not have the expertise needed and are intimidated by the skills needed in providing programs related to STEAM.”

**Staffing issues.** Staffing issues ranked third highest in frequency with eight instances. Staffing issues are defined as the dynamics related to knowledge bases, experience, interests, and

expertise as well as the staffing model for implementing STEAM programs. Of the 50 key phrases, viewpoints, or responses, four (19%) responses to IQ 2 were directly or indirectly related to staffing concerns. P2 noted the lack of job titles for cutting edge program needs.

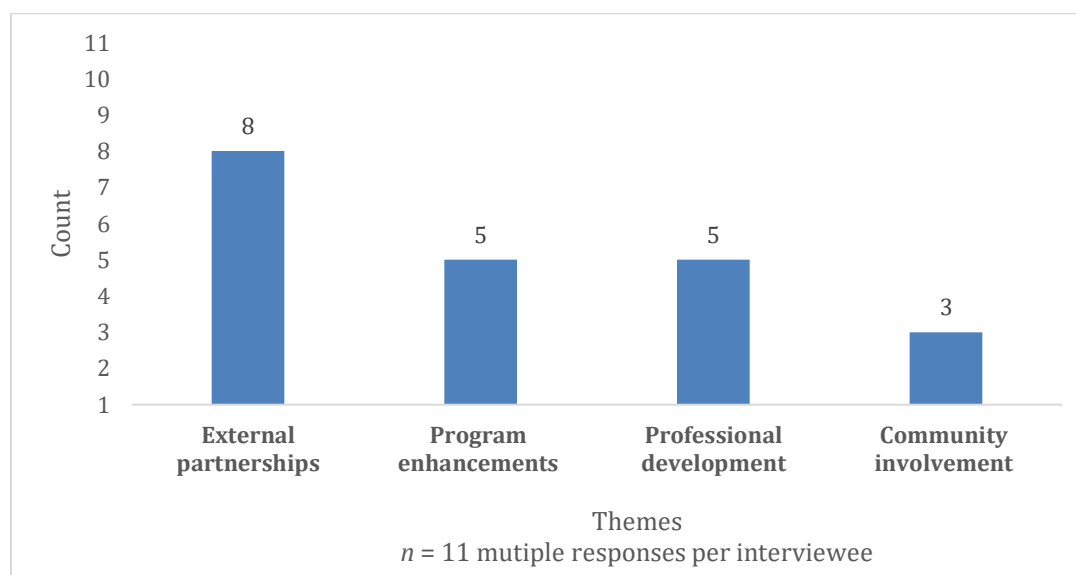
***Budget.*** Budget ranked fourth highest in frequency with five instances. Budget is defined as any aspect of the STEAM implementation that has a monetary value and influences the implementation process. Of the 50 key phrases, viewpoints, or responses, four (19%) responses to IQ 2 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Budgeting includes items such as funding allocations from the library system as well external grants and agreements. P9 stated that “sustainability is important because . . . we've gotten the library to buy into STEAM. However, the fact remains that the items need to be allocated as regular budget items.”

***Time management.*** Time management ranked fifth highest in frequency with four instances. Time management is defined as any aspect of the STEAM implementation that has a monetary value and influences the implementation process. Of the 50 key phrases, viewpoints, or responses, two (9%) responses to IQ 2 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Time management includes planning time for programs and schedules, including other duties not related to STEAM programs. P10 stated that “it’s difficult to find time to learn the technology.”

***Library narrative.*** Library narrative ranked sixth in the frequency with four instances. Library narrative speak to those unique occurrences in the community space. Of the 50 key phrases, viewpoints, or responses, two (9%) responses to IQ 2 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Library narrative includes items

such as formats that tell the stories that occur. P1 wondered, “Are we really telling our story and capturing what really happens in the STEAM space—and its impact?”

**Interview question 3.** IQ 3 asked, “How did you deal with or overcome the challenge in planning, design, implementation and post-implementation?” Through the analysis of all responses to IQ 3, a total of 30 key phrases, viewpoints, or responses related to how to deal with or overcome challenges faced in the STEAM implementation were identified. The key phrases, viewpoints, or responses were grouped into four common themes: (a) program enhancements, (b) external partnerships, (c) community involvement, and (d) professional development (see Figure 9).



*Figure 9.* Interview question 3: Coding results. How to deal with or overcome the challenges in STEAM implementation. The figure demonstrates the four themes that emerged from responses to interview question 3. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

**External partnerships.** External partnerships ranked the highest in frequency with eight instances. External partnerships are those community entities that support the mission of the library in its efforts to proliferate STEAM resources as well as provide some financial stability to

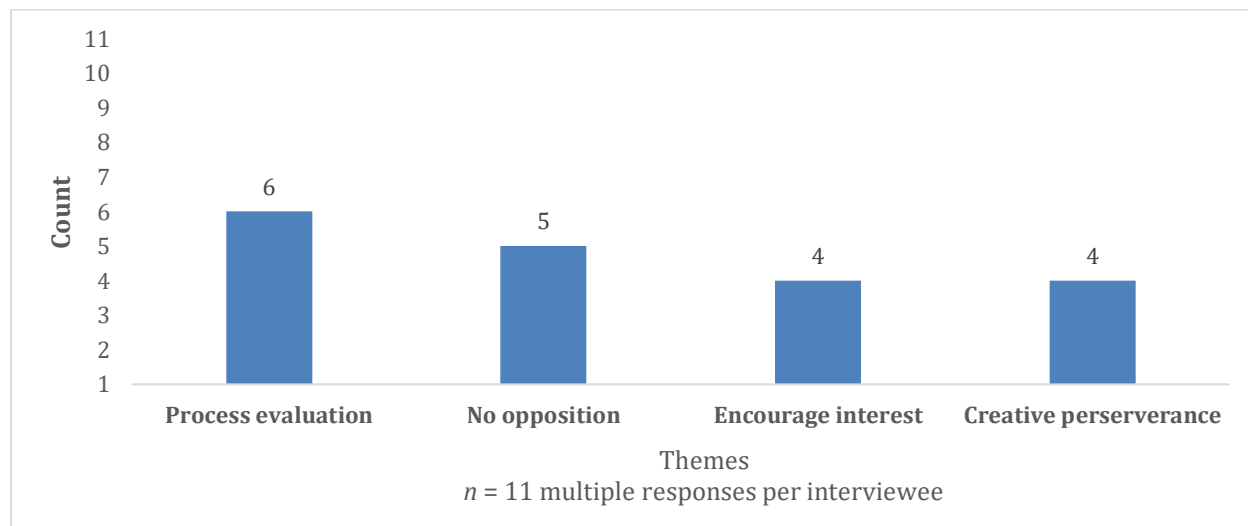
program efforts. Interview participants indicated that external partnerships are needed to overcome the challenges of implementation. Of the 21 key phrases, viewpoints, or responses, eight (38%) responses to IQ 3 were directly or indirectly related to overcoming the challenges faced in the implementation phase of STEAM. These partnerships often provide the staff training needed for STEAM programs. P9 also noted, “Transportation barriers are being addressed [by] businesses and other agencies that can assist youth in getting to the library.”

***Program enhancements.*** Program Enhancements ranked second highest in frequency with five instances. Program Enhancements are defined as items that are needed to create meaning and value for the programs offered by the library. Interview participants indicated that program enhancements are vital to overcoming the challenges in the implementation phase of STEAM. Of the 33 key phrases, viewpoints, or responses, five (23%) responses to IQ 3 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Programming includes items needed to address the challenge (a) program enhancement, (b) external partnerships, (c) community involvement, and (d) professional developments. P11 said, “Talking to people right now—whether they are colleagues, community members, or board members to help them understand that STEAM is pivotal to the library.”

***Professional development.*** Professional development ranked third in frequency with five instances. Professional development is defined as any resource that provides increased skill and comfort to overcome the challenges in implementation. Of the 21 key phrases, viewpoints, or responses, five (23%) responses to IQ 3 were directly or indirectly related to the challenges faced in implementation phase of STEAM. Professional development includes items such as training on the use of equipment. P6 identified the “the need for time to master the evolving technology.”

**Community involvement.** Community input ranked third highest in frequency with six instances. Community input speaks to the dynamics of neighborhood and their desires for programs. Of the 21 key phrases, viewpoints, or responses, three (14%) responses to IQ 3 were directly or indirectly related to community input as a mechanism for overcoming challenges related to STEAM implementation. P7 stated, “Invest in their interest” and P6 noted that librarians should “anticipate trends in technology.”

**Interview question 4.** IQ 4 asked, “How did you overcome resistance or opposition to your plan?” Interview question 4 yielded a total of 19 key phrases, viewpoints, or responses related to dealing with and overcoming resistance or opposition to the plan. The 19 key phrases were grouped into four common themes: (a) reevaluate process, (b) no opposition, (c) encourage interest, and (d) creative perseverance (see Figure 10).



*Figure 10.* Interview question 4: Coding results. How did you overcome resistance or opposition to your plan? The figure demonstrates the four themes that emerged from responses to IQ 4. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

***Process evaluation.*** IQ 4 yielded process evaluation as a notable solution for overcoming resistance or opposition to STEAM planning. Of the 19 key phrases, viewpoints, or responses, six (31%) responses to IQ 4 were directly or indirectly related to issues of process evaluation. Process evaluation includes evaluating planning, budget considerations, and communication strategies. P7 said that “overcoming opposition and resistance involved the methods for marketing and language used to communicate needs for STEAM programs.”

***No opposition.*** IQ 4 also yielded “no opposition” as the second highest response. Of the 19 key phrases, viewpoints, or responses, five (26%) responses to IQ 4 were directly or indirectly related to having no opposition. No opposition includes the library organization have free rein to develop a strategic model for STEAM with the goal of encouraging participation. P3 said, “The [school] district valued STEAM programming and therefore gave full support to all efforts.”

***Encouraging interest.*** Encouraging interest ranked the third highest response as a means for overcoming resistance to the plan. Encouraging interest was identified as one of the factors for dealing with resistance by breaking habits of traditionalism in service initiatives provided by today's libraries. Of the 19 key phrases, viewpoints, or responses, four (21%) responses to IQ 4 were directly or indirectly related to encouraging interest in STEAM programs. Encouraging interest includes by getting the word out to those who do not frequent the library. P5 spoke of encouraging interest through “the use of social media and newsletters and internal signage as a means of proliferating this cutting-edge programming.”

***Creative perseverance.*** Creative perseverance was another theme that emerged. Of the 19 key phrases, viewpoint, or responses, four (21%) responses to IQ 4 were directly or indirectly related to overcoming resistance or opposition to the plan for STEAM implementation. Creative perseverance includes developing new ways of overcoming rules that are not in alignment with



the creativity and flexibility need for STEAM implementation. P2 said, “There is a need to relax county requirements of the library to use one server. When developing programs and connectivity for cutting edge equipment, software or websites, the bandwidth exceeds what is allowed. Therefore, creative conversations . . . facilitate this need.”

**Summary of research question 2.** Research question 2 sought to identify the challenges that public libraries face as related to the promotion of informal learning programs focused on STEAM. A total of 14 themes were identified by analyzing key phrases, viewpoints, or responses to the three interview questions: programming, training, staffing issues, budget, libraries narrative, time management, program enhancement, external partnerships, community involvement, professional development, no response, process evaluation, encourage interest, and creative perseverance.

### **Research Question 3**

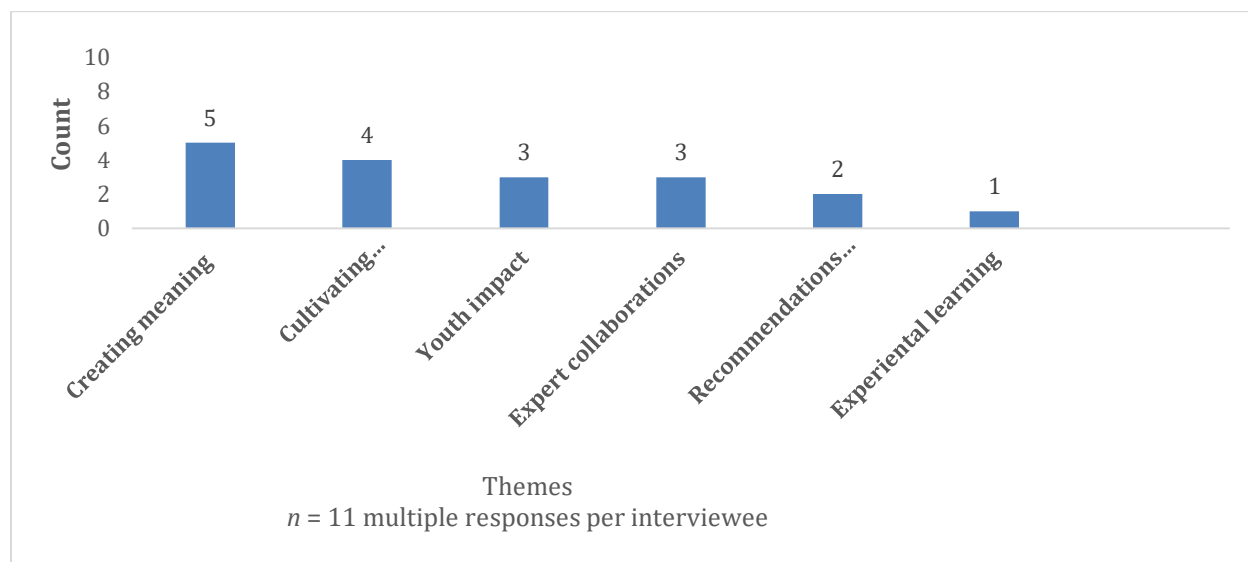
Research question 3 asked, “How do public libraries measure success in the promotion of informal learning programs related to STEAM?” There were two interview questions asked of each interview participants in order to provide answers for RQ 3:

- IQ 5. How did you define success for the STEAM implementation?
- IQ 6. How did you measure and track your success?

The responses from all interview participants for the two interview questions were analyzed for common themes that informed the overall responses to RQ 3.

**Interview question 5.** “How do you define your success for the STEAM implementation?” Through the analysis of all responses to IQ 5, a total of 33 key phrases, viewpoints, or responses were grouped into six common themes: (a) creating meaning,

(b) cultivating possibility in youth, (c) recommendations for improvement, (d) youth impact, (e) experiential learning, and (f) expert collaborations (see Figure 11).



*Figure 11.* Interview question 5: Coding results. How success is defined in STEAM implementation programs. The figure demonstrates the six themes that emerged from responses to IQ 5. Data are presented in decreasing order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

***Creating meaning.*** Creating meaning ranked highest in frequency for how public libraries define success in the promotion of informal learning programs related to STEAM. Of the 18 key phrases viewpoints, or responses, five (27%) responses to IQ 5 were directly or directly related to creating meaning for youth in the community. Creating meaning includes engaging teens in community activities in the public library that may provide improved outcomes for youth. P11 stated that “a successful program strengthens relationships as a result of providing access to tools in the library.”

***Cultivating possibility in youth.*** Cultivating possibility in youth ranked second highest in frequency for public libraries defining their success in STEAM. Of the 18 key phrases, viewpoints, or responses, four (22%) responses to IQ 5 were directly or indirectly related to cultivating possibility in youth. This theme includes how students respond to STEAM programs,

cultivating 21st-century skill sets, and providing experiences that lead to STEAM career paths. P9 said:

One demarcation for success would be to have 3-D printer to be as passe as a paper printer because you have so many people concerned with design thinking and concepts that you know the 3-D printer is no longer a destination but a matter of fact.

**Youth input.** Youth input ranked third highest in frequency for how public libraries define success in STEAM program efforts. Of the 18 key phrases, viewpoints, or responses, three (16%) responses to IQ 5 were directly or indirectly related to youth input. Youth input includes attendance, self-reflection, and the feeling of self-efficacy. P4 said, “The engagement level of students shows the immediate impact.”

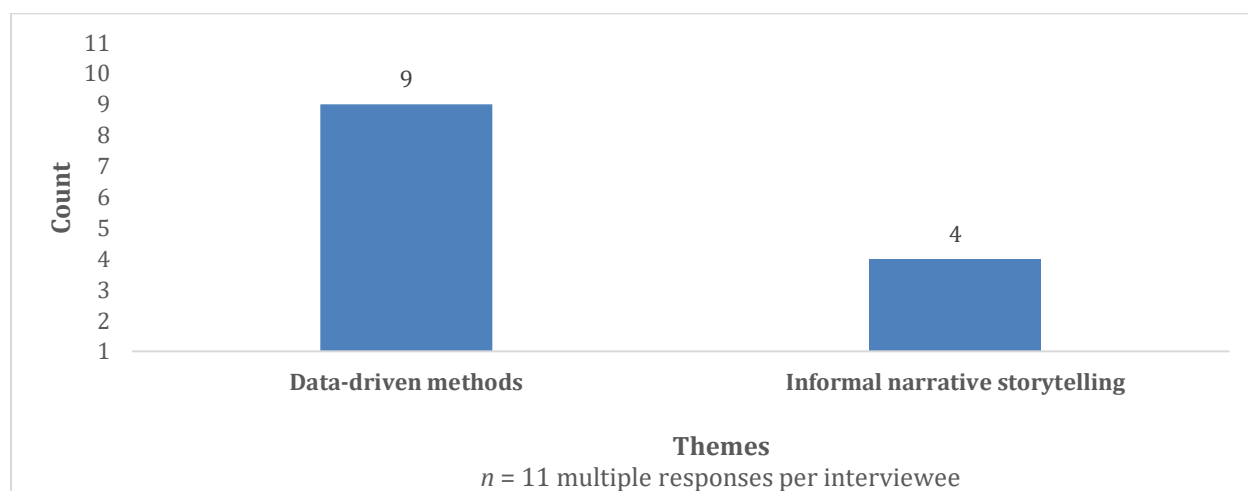
**Expert collaboration.** Expert collaboration ranked fourth in frequency for how public libraries define success in STEAM program efforts. Of the 18 key phrases, viewpoints, or responses, three (16%) responses to IQ 5 were directly or indirectly related to expert collaboration. Expert collaboration includes partnerships with other organizations of high learning as well as corporations that are STEAM-related and want to add value by teaching, mentoring, or coaching staff and students. P4 noted, “Partnerships with local universities are beneficial to students and staff and assist with building authenticity into the STEAM program.”

**Recommendations for improvement.** Recommendations for improvement ranked fifth highest in frequency for how public libraries define success in STEAM program efforts. Of the 18 key phrases, viewpoints, or responses, two (11%) responses to IQ 5 were directly or indirectly related to recommendations for improvement. Recommendations for improvement include getting narrative feedback after programs, recording statistics, and surveys that ask for

confidence level after program implementation. P8 said, “Measure individual training separately because it has its own outcomes and assessments that could be captured and tracked.”

**Experiential learning.** Experiential learning ranked sixth highest in frequency for how public libraries define success in STEAM program efforts. Of the 18 key phrases, viewpoints, or responses, three (16%) responses to IQ 5 were directly or indirectly related to experiential learning. Experiential learning includes hands-on learning using real world problems and produces ah-ha moments in the learning process. P1 defined experiential learning as “learners mak[ing] connections on their own when connecting previous experiences with current ones in a STEAM setting.”

**Interview question 6.** IQ 6 asked, “How did you measure and track your success?” Through the analysis of all responses to IQ 6, a total of 23 key phrases, viewpoints, or responses were identified as to how libraries measure and track success. The key phrases, viewpoints, and responses were grouped into two common themes: data-driven methods and informal narrative storytelling (see Figure 12).



*Figure 12.* How success is tracked and measured in STEAM programs. The figure demonstrates the two themes that emerged from responses to IQ 6. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

***Data-driven methods.*** Data driven methods ranked highest in frequency for how libraries track and measure success in STEAM programs. Of the 13 key phrases, viewpoints, and responses, nine (69%) responses to IQ 6 were directly or indirectly related to data-driven methods. The data-driven methods include counting people, evaluation of each program, tracking repeat attendees, shared spreadsheets of statistics, program attendance database, and evaluation tools. P1 noted:

We collaborate with the local university, [which assists us] by using a shared evaluation tool that . . . captur[es] statistics for the entire system so that we can better express our usage [and make a] strategic plan for future planning and funding.

***Informal narrative storytelling.*** Informal narrative storytelling ranked second highest in frequency for measuring and tracking success in public libraries. Of the 13 key phrases, viewpoints, and responses, four (31%) responses to IQ 6 were directly or indirectly related to informal narrative storytelling. Informal narrative storytelling includes staff debriefing in narrative format and daily survey of success stories noting that quality is more important than quantity. P3 “performs a pre-test and post-test of children and adults for every program as well as a reflection survey for every program from the librarian or lead instructor.”

**Summary of research question 3.** Research question 3 asked, “How do public libraries measure success in the promotion of informal learning programs related to STEAM?” The responses from all interview participants for the two interview questions were analyzed for common themes that informed the overall response to RQ 3. This question identified eight themes by analyzing key phrases, viewpoints, or responses to the two interview questions. The eight themes included (a) creating meaning, (b) cultivating possibility in youth,

(c) recommendations for improvement, (d) youth impact, (e) experiential learning, (f) expert collaborations, (g) data-driven methods, and (h) informal narrative storytelling.

#### **Research Question 4**

Research question 4 asked, “Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?” Three interview questions were asked of the interview participants in order to provide answers to RQ 4:

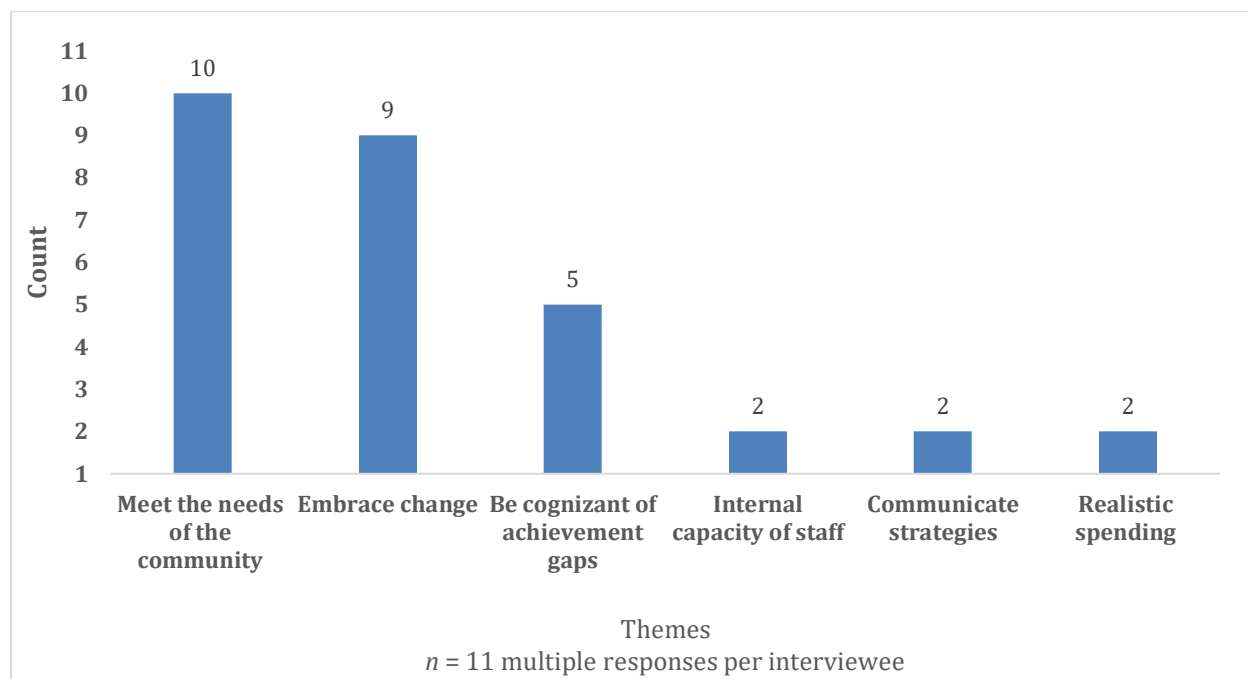
- IQ 7. What recommendations would you make for public libraries in the implementation process?
- IQ 8. If you could start over, what would you do differently?
- IQ 9. Is there anything else you would like to share?

The responses from all interview participants for the three interview questions were analyzed for common themes that informed the overall response to RQ 4.

**Interview question 7.** “What recommendations would you make for public libraries in the implementation process?” Through the analysis of all responses to IQ 7, a total of 50 key phrases, viewpoints, or responses were identified as recommendations for public libraries in the implementation process. The key phrases, viewpoints, and responses were grouped into six common themes: (a) meet the needs of the community, (b) embrace change, (c) be cognizant of achievement gaps, (d) internal capacity of staff, (e) communicate strategies, and (f) realistic spending (see Figure 13).

***Meet the needs of the community.*** Meeting the needs of the community ranked highest in frequency for IQ 7. Of the 30 key phrases, viewpoints, and responses, 10 (33%) responses to IQ 7 were directly or indirectly related to meeting the needs of the community. Meeting the needs of the community includes knowing your community and what’s missing, be adaptable,

and removing barriers to access. P8 said: “Always be intentional, knowing your community and market. It is also essential to know your collection and brand it.”



*Figure 13.* Interview question 7: Coding results. Recommendations for public libraries in the implementation process. The figure demonstrates the six themes that emerged from responses to IQ 7. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

***Embrace change.*** Embracing change is essential as a recommendation for public libraries in the implementation of STEAM programs. Embracing change ranked second highest in frequency for IQ7. Of the 30 key phrases, viewpoints, and responses, nine (30%) responses to IQ 7 were directly or indirectly related to embracing change. The practice of embracing change means “we must recognize that when things change, we as librarians/mentors also change in service and program delivery” (P1).

***Be cognizant of achievement gaps.*** The practice of being cognizant of achievement gaps ranked third highest in frequency as a recommendation for public libraries in the STEAM implementation process. Of the 30 key phrases, viewpoints and responses, five (16%) responses

to IQ 7 directly or indirectly related to recommendations for public libraries in the implementation of STEAM programs. Being cognizant of achievement gaps requires researching the curriculum requirements for local schools as well as being proactive in the enforcement of the library's mission to provide learning opportunities. P3 spoke of the importance of "being aware, locally and nationally, of the achievement gaps and really studying what's going on in your public schools, your private schools, and where those gaps are."

***Internal capacity of staff.*** The internal capacity of staff ranked fourth highest in frequency for recommendations for public libraries implementing STEAM programs. Of the 30 key phrases, viewpoints, or responses, two (6%) responses to IQ 7 were directly or indirectly related to the internal capacity of staff. This internal capacity of staff includes capitalizing on the strengths of the workforce and finding out which skill sets are internal that may provide training and facilitation of STEAM programs. P11 recommended that librarians "take stock of where you are today, know the strengths of your staff, and perform an internal assessment of your own skills, as well as staff knowing current capacities and opportunities."

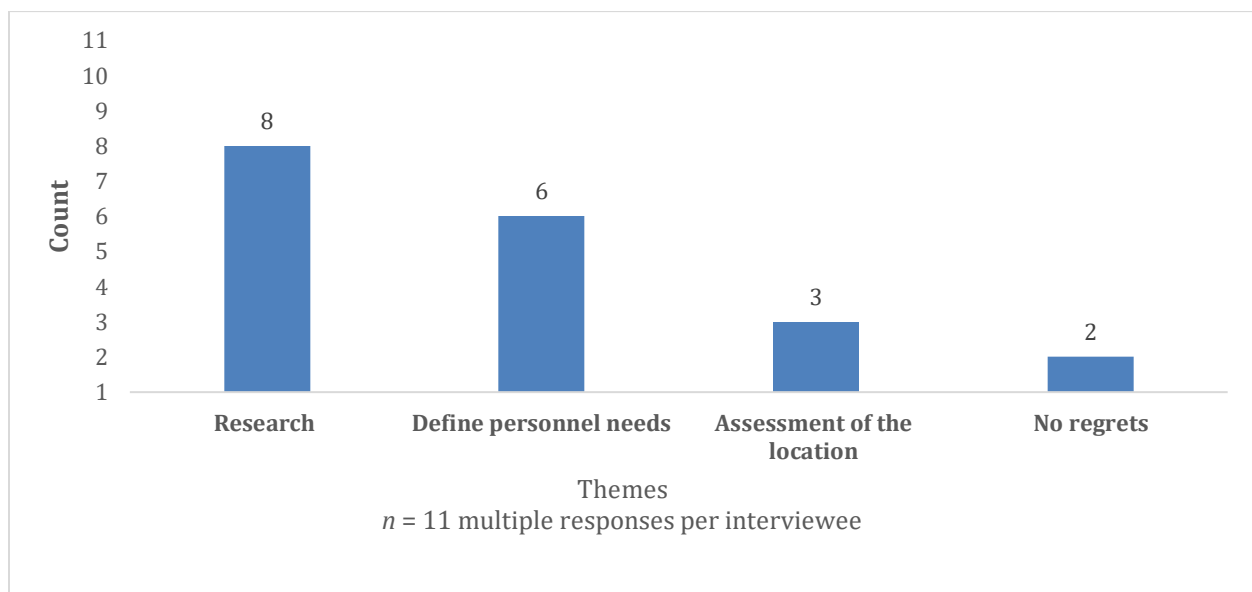
***Communicate strategies.*** The practice of communicating strategies ranked fifth highest in frequency of recommendations for public libraries implementing STEAM programs. Of the 30 key phrases, viewpoints, or responses, two (6%) responses to IQ 7 were directly or indirectly related to communication strategies. The task of communicating strategies includes actively communicating with staff, leadership, governing bodies, partners, and community. P11 offered this example:

The community librarian or the lead instructor must have a conversation with the technologist to assure that the Internet or Wi-Fi does not impede a program unnecessarily because staff failed to communicate the kind of program and technology needs.



**Realistic spending.** Realistic spending ranked sixth in frequency for recommendations for public libraries and the implementation of STEAM programs. Of the 30 key phrases, viewpoints, and responses, two (6%) responses to IQ 7 were directly or indirectly related to realistic spending. Realistic spending includes not getting caught up in buying stuff and evaluating where money is being spent and why. P11 advised, “Don’t buy a kit! Don’t buy a kit! Be aware of gimmicks, be aware of changing technology and evaluate your in-house talents.”

**Interview question 8.** “If you could start over, what would you do differently?” Through the analysis of all responses to IQ 8, a total of 20 key phrases, viewpoints, or responses were identified as to what librarians would do if they could start over in the implementation process. The key phrases, viewpoints, and responses were grouped into four common themes: (a) research, (b) define personnel needs, (c) assessment of location, and (d) no regrets (see Figure 14).



*Figure 14.* Interview question 8: Coding results. Figure 14. If you could start over, what would you do differently? The figure demonstrates the four themes that emerged from responses to IQ 8. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

***Research.*** Research ranked highest in frequency for IQ 8. Of the 19 key phrases, viewpoints, and responses, eight (42%) responses to IQ 8 were directly or indirectly related to research. Research includes investigating trends in technology as well as what is happening in other libraries and examining outcomes and assessments earlier in the implementation. P9 warned: “Be aware of technology turnover when purchasing software; some upgrades become obsolete overnight.”

***Define personnel needs.*** Defining personnel needs ranked second highest in frequency for IQ 8. Of the 19 key phrases, viewpoints, and responses, six (32%) responses to IQ 8 were directly or indirectly related to defining personnel needs. Defining personnel needs includes pushing harder for staff acquisition and preparing for the interview process to be disruptive to programs; therefore, planning ahead for coverage while in the staff acquisition process. P6 said: “Staff for STEAM efforts should be a separate hiring process without typical duties of traditional staff.”

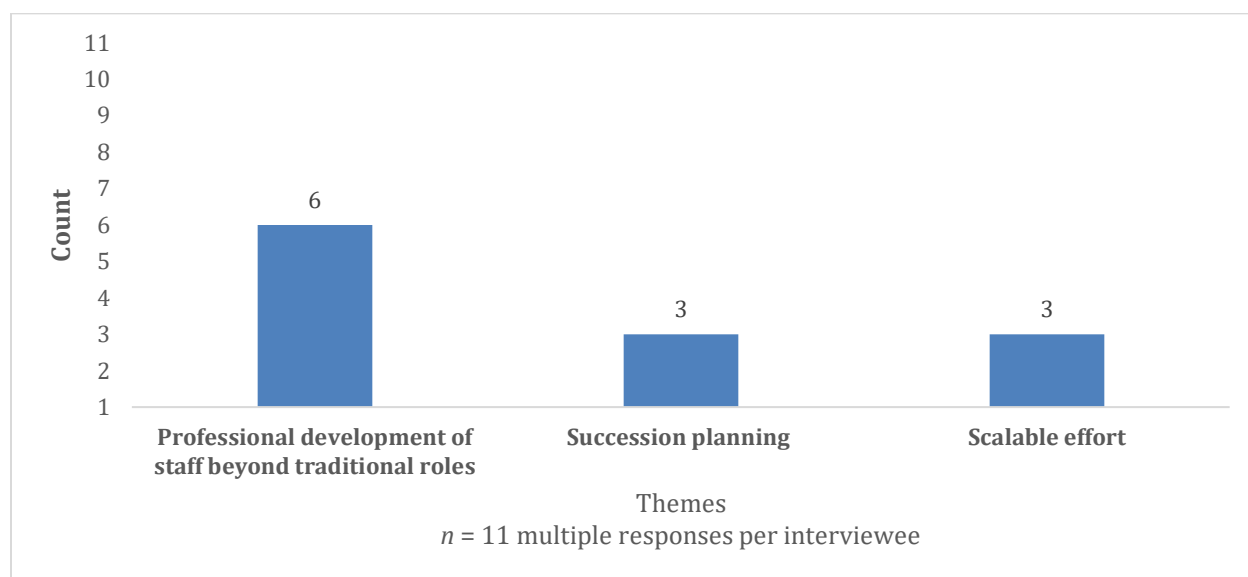
***Assessment of the location.*** Assessment of the location ranked third highest in frequency for IQ 8. Of the 19 key phrases, viewpoints, and responses, three (15%) responses to IQ 8 were directly or indirectly related to the assessment of the location. Assessment of the location involves evaluating the extent of the STEAM program offered and what technical as well structural negotiations will be needed to make effective use of the space. P1 explained:

The installation of a sink would have been a nice feature in the makerspace for use when having programs that involve messy materials or for simple cleaning of the space. . . .

There needs to be some consideration for the technical infrastructure and making decisions about the purchase of equipment with that in mind.

**No regrets.** No regrets ranked fourth highest in frequency for IQ 8. Of the 19 key phrases, viewpoints, and responses, two (11%) responses to IQ 8 were directly or indirectly related to having no regrets. This theme was voiced by librarians and staff who expressed that they were satisfied with the present status of their STEAM programs and would not change anything. P6 said, “Everything has been a great learning process.”

**Interview question 9.** “Is there anything else you would like to share?” Through the analysis of all responses to IQ 9, a total of 17 key phrases, viewpoints, or responses were identified and grouped into three common themes: (a) professional development of staff beyond traditional roles, (b) succession planning, and (c) scalable effort (see Figure 15).



*Figure 15.* Interview question 9: Coding results. Is there anything else you would like to share? The figure demonstrates the three themes that emerged from responses to IQ 9. Data are presented in descending order of frequency. The numbers in each theme indicate the number of times a direct or indirect statement was made by interview participants that fell into the respective theme category.

**Professional development of staff beyond traditional roles.** Professional development of staff beyond traditional roles ranked highest in frequency for IQ 9. Of the 12 key phrases, viewpoints, and responses, six (50%) responses to IQ 9 were directly or indirectly related to

professional development of staff beyond traditional roles. Professional development of staff beyond traditional roles includes obtaining 21st-century skills, building science literacy and being competent in all areas. P19 said:

The demands of our community are far too complex for us to assume that the masters of library and information science [degree] can prepare us to be able to develop and execute the diversity of programming that meets the needs of the community.

***Succession planning and scalable efforts.*** Succession planning and scalable efforts scored equally second in frequency for IQ 9. Of the 12 key phrases, viewpoints, and responses, three (25%) responses to IQ 9 were directly or indirectly related to succession planning. Succession planning involves thinking strategically about identifying and developing staff leaders who can replace current cutting-edge leaders in implementing STEAM in public libraries. P2 noted “a need to leverage the responsibilities and job titles for the next generation of staff because we have to integrate other professions in other expert areas to change the culture.” Scalable efforts scored second for question 9, “Is there anything else you would like to share?” Of the 12 phrases, viewpoints, and responses to IQ 9, three (25%) responses were directly or indirectly related to scalable efforts. Scalable efforts include libraries of varying sizes having the ability to implement STEAM initiatives. P6 encourages others to not be intimidated by STEAM and to realize that any library can do STEAM programs without purchasing technology.

**Summary of research question 4.** Research question 4 asked, “Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?” A total of 13 themes were identified by analyzing key phrases, viewpoints, or responses to the three interview questions. The 13 themes included (a) meet the needs of the community, (b) embrace change, (c) be cognizant of achievement gaps, (d) internal capacity of staff,

(e) communicate strategies, (f) research, (g) define personnel needs, (h) assessment of the location, (i) professional development of staff beyond traditional roles, (j) succession planning, and (k) scalable efforts.

## **Chapter Summary**

The purpose of this study was to determine the challenges that the public library experiences in the implementation of STEAM programs, strategies, and practices employed by the public library in managing the implementation, and how the public library measures success in the process. To accomplish this task, 11 persons responsible for STEAM programs in public libraries were recruited as interview participants for the study. All participants were asked nine semi-structured interview questions designed to inform four research questions:

1. What strategies and practices have been implemented in public libraries that focus on informal learning opportunities related to STEAM?
2. What are the challenges that public libraries face related to the promotion of informal learning programs focused on STEAM??
3. How do public libraries measure success within informal learning programs related to STEAM?
4. What lessons have been learned in the development of informal learning spaces focused on STEAM in the public library?

Data for this study were collected through 11 semi-structured interviews. The researcher coded the data and validated the results with the assistance of two interraters who were Pepperdine University doctoral candidates. Data analysis was conducted employing the phenomenological approach explained in Chapter 3. Data analysis yielded a total of 41 themes. Table 6 provides a summary of all the themes obtained through the data analysis process.

Chapter 5 presents a discussion of themes, implications, recommendations, and conclusions of the study.

Table 6  
*Summary of Themes for Four Research Questions*

RQ 1. Strategies and Practices	RQ 2. Challenges	RQ 3. Measurements of Success	RQ 4. Lessons Learned and Recommendations
collaborative involvement	programming	creating meaning	meet the needs of the community
promote innovative learning	training	cultivating possibility in youth	embrace change
dynamic development	staffing issues	recommendations for improvement	be cognizant of achievement gaps
career pathways	budget	youth impact	internal capacity of staff
structures strategies	library narrative	experiential learning	communicate strategies
access and equity	time management	data-driven methods	research
	program enhancements	informal narrative storytelling	define personnel need
	external partnerships		assessment of the location
	community involvement		professional development of staff beyond traditional roles
	professional development		succession planning
	process evaluation		scalable efforts
	encourage interest		
	creative perseverance		

*Note.* This table demonstrates a summary of all of the themes derived through the data analysis process.

## **Chapter 5. Conclusions and Recommendations**

Chapter 5 presents an analysis of the literature and data collection and provides a review highlighting the findings and their relationship to the current literature. In addition, this chapter details implications of the study, recommendations for future research, and final thoughts. This study also contributes to the existing body of literature on public librarians and STEAM efforts.

The library and library profession are in a constant state of change; however, few have aggressively taken steps to redirect the strategic direction of libraries in an area that could potentially add relevance to the profession as well as the physical space. This study highlighted the voice of 11 participants who reflect the actions of over 17,000 public libraries in the United States that have developed and implemented some form of STEAM programming in public settings. An unintended consequence of this study validated the argument in a book of essays by Josiah Quincy (Shera, 1945) concerning “the public library as one secular institution with self-development as its aim” (p. 546). The public library is a social institution (Martin, 1937), an edifice likened to other social bodies such as governments as political institutions, the family and religion, schools of high education, corporate entities, medical systems, and legal systems. The public library today meets the needs of humans and embrace a system of behaviors and patterns that are interwoven and span across the entire society.

The public library continues to provide opportunities for those who seek access, knowledge, and pathways to a better tomorrow. STEAM, in this public space, is yet another service that has been elevated throughout the United States in various forms with the sole intent of proliferating science through informal learning initiatives. Similar to the experiences of many organizations affected by the disruptive technologies in the workplace, the public library has not been able to keep an advanced pace ahead of the changing technology. In this instance of

STEAM programming as a project-based learning practice, the concept that the library is trying to offer can be related to what Blackner (1993) described as an organizational learning practice. STEAM has become a subset of organizational learning practices that are urgently required in the establishment of study and practices related to science education in the public library. My experience, in alignment with participants in this study, is very relatable in the expressed lack of time or professional development to keep pace with the personal learning demand when implementing the next generation of industry trends while trying to present current and relevant program offerings for youth. Today's STEAM leaders are actually learning from and through projects rather than leading the plan and reacting based on the need.

The paradigm shift in the library model to facilitate STEAM initiatives is one element of change that has immersed as a result of technology and its influence on the service model and the need for additional knowledge (Edwards, 2009; Mattern, 2014). The effect is noted in the skill sets needed as well as a change in the scope of work and the way in which it affects the traditional acquisition and development of program needs. The role of the library in the life of the community it serves has evolved with new and improved models of success that speaks to the now altered service to the public. This transition has presented itself in the reimagination of space, the provision of program efforts that have spanned beyond the traditional initiatives of a few years ago and continue to do so as libraries renovate and build new structures that attract new populations wanting a higher level of knowledge attainment (Stark, 2013). In order to remain relevant and continue significant connections as civic commons to the community, the library professionals have reconciled a need by observing a change in the community's demand (Dewe, 2017). This need has been addressed by recognizing trends across the nation related to



STEAM and the differences related to access, usage, skills and self-perception that influence implementation and participation.

The findings of this study call attention to the need for strategic measures involving community collaboration in the proliferation of STEAM as a dynamic effort for public libraries and its role in promoting innovative learning opportunities for all. One such need is an overall understanding of STEAM and support from governing bodies, which would require mandates on a district or state level. Funding is also one aspect for a long-term STEAM initiative that requires a fluid mechanism, for funding that does not fall into the rigid guidelines of procurement that most libraries who are dependent on county or city financial support. Another aspect is the acquisition of staff and the need for a having the technical expertise in addition to library science or have prior experience that lends to the unique trends in STEAM. Participants in this study who have expertise or prior experience related to STEAM or have experience with teaching seemingly have programs that are greater in magnitude and planned aggressively for future programs with an awareness of future trends and work accordingly. This theme is also related to the literature that speaks to the public library adopting projects in order to become change-adept, the need to prepare librarians in organizational competencies, and the need to evaluate the conventional image of knowledge as being located within the literature rather than the brains of the employee (Blackner, 1993), as knowledge work is dependent on the expertise of the staff as a result of the new communication technologies in STEAM programs.

### **Grassroots Development and Making Meaning**

The exploration of materials and ideas is not a new concept, as stated by one of the participants noting that the focus on making meaning is based on a past conceptualization of inquiry-based experience and skills-based training in the form of apprenticeship in what was

once an agrarian society. STEAM programs provide an opportunity for youth to investigate and engage in problem solving and critical thinking about their future in a public space. The findings from the research as well as the 25 years of practical experience by the researcher also recognizes a basic level of development of STEAM efforts at the community level. Core components of school and neighborhood in the development of programs are desired by its constituents. This is indeed a grassroots movement for many of the participants in this study, focused on creating meaningful experiences that can potentially lead to youth development. The majority of the participants have been charged with developing and implementing STEAM programs without prior chartered strategies or best practices. The efforts are described as “considerate” by one participant, meaning that many considerations for the youth involved have to be taken into account, such as providing opportunities for employment for these youth who have volunteered to assist, and developing a program internally that can provide leverage for youth on a larger scale with experience, employability, and job skills.

The researcher, similarly to the participants, developed successful programs that are hinged upon what I describe as grassroot efforts to carry out a mission of information in the area of science. The majority of the participants have executed these programs with fortitude that is self-directed and very new to the profession. One participant describes the task as having to innovate early and often, which requires learning new technology on your own time in order to stay abreast of changing technology. The knowledge needed in the implementation is uncharted and innovative, using a trial and error methodology. Many programs were solely the responsibility of STEAM believers who sought nontraditional funding, grants from corporate entities, and the involvement of other educational institutions to proliferate the community’s need for science learning. These grassroots efforts have formed the foundational model for future

development of science programs. These efforts can be furthered developed by library systems and lead to STEAM librarians or staff creating collaborative networks with neighboring countries, districts, and states among themselves in order to share and establish resources based on best practices of existing programs.

### **Specialized Skills**

One theme that recurred throughout the research was the need for persons with specialized interest in STEAM or persons who have amalgamated prior experience and professions who seek out such opportunities within a library setting. Findings show that 50% of the participants had preexisting knowledge in the areas of science and were specifically looking for opportunities within a library system. Fifty percent were not librarians by profession but knew that their skills and talents were needed within the library and applied them accordingly. Fifty percent of the participants were former teachers with knowledge of curriculum development and existing knowledge in STEAM. Twenty percent of the participants spoke emphatically of their experience in other professions and directed programs based on their prior knowledge of industry needs. Eighty percent of the participants had full autonomy in the assessment and development of the program initiatives and have been successful with the support of leadership within the organization. Therefore, most programs were developed without a preassessment of conditions, including the physical structure and the implications of a STEAM program; therefore, many organizations are retrofitting for STEAM and makerspace in facilities without having factored in the development of the structure. One example is related to the initial STEAM influx of programs centered around technology and the acquisition of equipment. The equipment includes items such as laptops, software packages, without fully understanding the limitation placed on many public libraries as it relates to the Wi-Fi capability and the impact of

Internet access being flooded by several devices. The license requirements for software and limited usages based on licensure, installation of platforms on equipment with limited memory, and basic items such as a sink for arts and crafts or the procurement process for technology were sometimes outdated before receipt because of the lack of good procurement processes.

## **Kits**

The participants in the study have at least two years of consistent programs and many have experienced great success. While success was gradual for some without any prerequisite directions, many used a trial-and-error method for developing each program. Therefore, participants deduced what worked and what didn't work. Some initially started with what they personally desired to teach and offer, some were youth directed with a space and platform for development with no requirements but a free form space for exploration. Some developed curricula and focused on a system of themes with a set of expectations for completion and moving to the next level of development. In this instance, the participants began to lead the development of the STEAM program with their own ideas, and the leader simply facilitated based on the expressed desires. One participant found a lot of interest in kits and then realized abundance of kits had been purchased that youth were no longer interested in after the task had been completed, which led to a discussion on kits.

Many programs in this study began with kits, later to find that technology nor kits are required for the execution of a STEAM program. One participant asked the public for ideas by offering a wall to post sticky notes of what they wanted. She began to listen and centered the purchase of items in tandem with the community's willingness to contribute. The program expanded to an astronomical level of participation. Eighty percent of this study's participants warned against purchasing prior to getting an understanding of what the community wants. As a

professional librarian and observer of the purchase of kits, this researcher has found that while there's an inherent notion that purchasing kits is a desire for many libraries as they embark of program development, clear objectives are necessary for purchasing choices that are combined with other activities to provide some guided instruction that reaches the need of the participant or community. My recommendation, based on the research from this study and personal experience, is to develop a curriculum with a clear vision that provides deeper fundamental knowledge beyond a replicated program.

### **Summary of the Study**

The purpose of this study was to investigate existing and needed strategies employed by informal learning spaces such as public libraries and their implementation of STEAM programs. The study also addressed the challenges faced in the development of STEAM programs in public libraries. This investigation also measured, by extension, related successes in the public library and sought to discover overall recommendations for the implementation of exemplary STEAM initiatives that substantiate the public library as a recognized entity in STEAM education. Guided by the literature review, four research questions and nine open-ended interview questions were developed to inform this study. The study was designed as a qualitative study utilizing a phenomenological approach. The research employed a phenomenological approach that studied the meaning of experiences as they are lived; provided opportunities to collect descriptive, reflective, and interpretive data; and engaged a means for conversation on the essence of the experiences (Richards & Morse, 2013; Van Maanen, 1979).

Participants for this study were identified through a series of Google searches, using an ascribed set of keywords. A purposive sample of 11 participants was identified as a result of saturation for this study. Participants were in the age range of 18 to 65, worked in a public

library, and developed and implemented a series of programs over the course of a several months, as well as had some experience with pathways for partnerships, grants, and collaborative efforts with experts in the field of STEAM.

The study began with a Google search using a number of keyword combinations to capture public libraries that met the criteria for significant STEAM programs. The search instantly produced a list of results from all over the Internet that matched the query. The search yielded hits with the noted keywords, and the researcher assessed each one, looking for key information about STEAM programs. A master list was created, based on the results, and 83 invitations were e-mailed to libraries that met the criteria. The recipients were all in the United States, representing 24 states of 50 states plus the District of Columbia and Puerto Rico.

As a result, 27 states out of 52 were invited, with 51% of states represented in the e-mailings and 40% of the 27 recipients participating. Of the participants, half have developed cutting-edge programs and have provided significant leadership in the STEAM movement in the United States in training, and resource sharing, as well as literature that has provided some guidance to the profession. Of the 11 participants, 5 of the 11 were former teachers, which meant 45% of the participants had other expertise in science, with one being an expert but not a librarian. Of the 11 participants, 9 are librarians. Invitations were sent based on the results of several Google searches combining the terms *STEAM*, *STEM*, *MAKERSPACE*, and *public libraries*. Librarians need personnel who have a clear understanding of the technology acquired and must also develop relationships that allow for full expression of the library's needs; however, most libraries do not have their own information technology (IT) division and rely on IT departments that are outside the departments they manage. Success requires the public library

to be purposeful in the creations of meaning through programs that ascribe to youth developing and helping to cultivate possibility in future generations.

The maximum variation method assisted the researcher in discovering the unique, best practices of persons involved in informal learning and STEAM in the public library who have experienced the same phenomenon. The criteria for maximum variation was used to include (a) librarians or STEAM professionals, (b) demonstrated involvement with STEAM programming efforts, (c) experience with networking, and (d) varied experience. The data collection for this study was done through semi-structured interviews with 11 participants. Participants were asked nine open-ended questions that were developed and validated through an interrater and validity procedure. The reliability and validity of the data collection instrument was obtained through a three-step process: (a) *prima facie* validity, (b) peer-review validity, and (c) expert review. Data collected through the interviews were audio recorded and transcribed to word documents. The data were then analyzed and coded to determine common themes. Validation of the codes and themes was accomplished through an interrater review procedure. As a result of the interrater review process, four edits were made to the initial codes as reported in Chapter 4. Last, the findings of the study were summarized and displayed in bar charts that tabulated and reported the number of key phrases, viewpoints, or responses that fell under a particular theme. The findings across the four research questions and the corresponding interview questions were directly related to a need for assessment in functions, community needs, and training. All findings had an implicit relationship with the three learning theories that guided the literature and research as it relates to informal learning in non-school settings.

The desire of the public library is centered around providing situated learning efforts that arise as meaningful actions that may potentially grow into stable interest in the sciences.

Cognitive learning theories that support stability are present some of the time and later nonexistent. The implications of STEAM in public settings also support the theory of social engagement while sharing in the learning process and gaining support in the discovery of learning that exists in the development of makerspaces in public libraries as collaborative spaces that provide hands-on interaction to cultivate opportunities for new activities, such as sewing or coding for those with no prior experience. The chart below speaks to the recurrence of themes related to learning theories that support the literature on STEAM initiatives as informal learning. (see Table 7).

Table 7  
*Summary of Findings and Related Theories*

Themes	Situated Learning Theory	Cognitive Learning Theory	Social Learning Theory
collaborative involvement	•		•
promote innovative learning	•		•
dynamic development	•		
career pathways	•	•	
structures strategies	•		
access & equity	•		
define personnel needs	•	•	
assessment of the location	•		
professional development of staff beyond traditional roles	•	•	
succession planning	•	•	
scalable efforts	•		
programming		•	
Training		•	
staffing issues		•	

(continued)



Themes	Situated Learning Theory	Cognitive Learning Theory	Social Learning Theory
Budget		•	
library narrative		•	
time management		•	
program enhancements		•	
external partnerships		•	•
community involvement		•	
professional development		•	
reevaluate process		•	•
encourage interest		•	
creative perseverance		•	
creating meaning	•		•
cultivating possibility in youth	•		•
recommendations for improvement	•		•
youth impact	•		•
experiential learning			•
data-driven methods			•
informal narrative storytelling			•
meet the needs of the community	•		•
embrace change	•		•
be cognizant of achievement gaps	•		•
internal capacity of staff		•	•
communicate strategies			•
Research			•

## Discussion of the Findings

The findings of the study are intended to identify the best practices for the implementation of STEAM programs in a public library system and advancing the informal learning

opportunities within public spaces. The following section provides further discussion of the findings and themes that were derived from the interview responses. Further, the findings are compared to the existing literature to determine whether the results agree, negate, or add to the existing body of knowledge.

**Results for research question 1.** Research question 1 asked, “What strategies and practices have been implemented in public libraries to promote informal learning opportunities related to STEAM?” An analysis of the responses and themes derived indicate that the strategies and practices implemented in public libraries to promote informal learning opportunities related to STEAM are centered around the following six areas:

- community collaborations as a means for sustainability,
- the creation of confidence through cutting edge learning opportunities,
- the need for aggressive approaches to program development,
- how content creation stimulates thinking of future endeavors,
- creating spaces that promote expected outcomes, and
- public spaces that allow for self-regulated learning that creates awareness.

**Discussion of research question 1.** The purpose of the study was to identify the best practices that STEAM leaders have employed to make programs efforts successful in public libraries. Research question 1 explicitly focuses on identifying the strategies and practices that STEAM leaders exert to make the programs successful. The findings to research question 1 suggested that a STEAM leader requires a comprehensive understanding of STEAM initiatives and the need for interdependence on collaboration between the library community and the community at large. The strategies and practices are dependent on the level of interaction with the initial conceptualization of idea sharing for libraries developing and implementing STEAM

initiatives. As such, STEAM leaders in the study sought to build community through proactive conversations about the desires of their constituents related to doing science. As a result, the STEAM programs give agency to youth and give a voice to their desires and future endeavors. P1, describes the phenomena as “a space within the library for people to come together and to begin to think together and to begin to think of the library.”

According to Bostwick in 1917 in *The American Public Library*:

The modern public library is required to be an active space, not merely a passive, force; not only guarding and preserving its books, but also proving access and it tries to see that those who need them realize that need and act according. (Bostwick, 1917, pp. 1–2)

This statement has relevance to this study that speaks of access to and equity in knowledge attainment, which STEAM programs provide. The study findings in research question 1 highlighted the vigor that is required of a STEAM leader in the public library and the flexibility that leadership has to demonstrate in support of this dynamic environment that has some structure; however, the fluidity of effort is what determines the outcomes for the students attending informal learning programs.

**Results for research question 2.** Research question 2 asked, “What are the challenges that public libraries face as it relates to the promotion of informal learning programs focused on STEAM?” Analysis of the derived responses and themes indicated that the challenges public libraries face related to the promotion of informal learning programs focused on STEAM are centered around 13 areas:

- navigating through the varying nuances of program development from development to implementation,

- the lack of training opportunities for staff in preparation for STEAM inquiry-based programs,
- the lack of knowledge on the part of the governing body on the scope of STEAM, job descriptions, and title delineations,
- the need for clarity on budgeting for sustainability,
- the organizational need to formalize how the STEAM story is captured and quantified,
- the need for staff time to acquire technology, learn the technology, and then teach to other staff for programming,
- the library's need for a strategic plan for STEAM implementation,
- the development of external mechanisms for dealing with challenges,
- the desires of staff for formal, professional development to build staff interest in STEAM implementation,
- examining the language and strategy used to communicate needs,
- outreach to the non-library-using constituents, and
- assisting governing bodies to understand what STEAM is and the need to do business in a different way for this initiative.

**Discussion of research question 2.** The purpose of the study was to identify best practices for the implementation of STEAM programs in a public library system and advancing the informal learning opportunities within public spaces. Research question 2 specifically focused on identifying the most notable challenges that public libraries face in the promotion of informal learning programs focused on STEAM. Ruth Baleiko (as cited in Morehart, 2015) described future libraries as structures that support and enhance navigation and exchange with time and demand as the caveat for service that is almost collection free and a bevy of technology.

Question 2 speaks to the challenges of such a space and a new service model that poses difficulties that are different from some traditional services still being offered within the same space—a juxtaposition to a makerspace or computer lab conducting a coding project. Although the two STEAM programs are engaging and inquiry-based, much of the remaining library exist within a different cognitive space. Participant 1 said, “It’s mostly me; however as manager, I have other duties as well and beyond the scope of the job description.” Other challenges are situational and may differ from one library to another, depending on the skill sets of the STEAM leader. Many librarians develop external mechanisms for dealing with challenges because they have full autonomy of the program as the resident expert on STEAM. Budgeting for technical needs with the confines of a county’s spending year doesn’t always satisfy the need to sustain a program. Some study participants experienced issues related to material depletion before the end of a budget year or faced constraints on budget deadlines and the need to purchase according to the due date as opposed to the program plan. Sometimes this spending mode is not effective, as software updates and versions of software and technology become obsolete sometime prior to the receipt of the items. Many of the experiences shared demonstrated the need for a program implementation strategic plan, with clearly defined expectations based of the structure of the program and not the spending year.

**Results for research question 3.** Research question 3 asked, “How do public libraries measure success in the promotion of informal learning programs related to STEAM?”

An analysis of the responses and themes derived indicate that libraries measure success in the promotion of informal learning program related to STEAM around seven areas:

- the provision of programs that are meaningful, that empower people,
- fostering learning that support career development,

- community input on programs,
- increased levels of engagement by youth,
- celebrating the achievement of students in obtaining new skill set,
- evaluation tools and mechanism, and
- informal methods that tell the library's story.

**Discussion of research question 3.** The findings from RQ 3 indicated that for many libraries the most notable measurement of success (30% response rate) was creating a sense of meaning. The library by its nature is place in the community, as noted by Buschman and Leckie (2007). The library has a direct relationship with and resides in the hearts and minds of the community. The findings expressed that the library is indeed a cultural space and has been so through every period of history. The participants reflected on the importance of the community involvement in the development of program initiatives and the overall concern of creating a community of care in the midst of learning and engagement. The library was describing by P4 as life changing in the offering of STEAM to youth and creating agency.

The opportunities that present themselves involving STEAM programming for a hands-on learning experience in public spaces were especially appreciated when learners made the connection between a previous task with a new task. Much of this information is captured through traditional data collection methods using people counters, attendance, and evaluation forms; however, informal methods also appeared in the study. Examples included a daily survey of success stories, pre-surveys and post-surveys. The informal methods lent themselves to narrative stories about experiences in the STEAM spaces, such as described by P3, about a reflection survey that allow the patrons to tell their stories. Another attribute that arose was a desire by participants for programs to be worthwhile and more about quality than quantity.

**Results of research question 4.** Research question 4 asked, “Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?” An analysis of the derived responses and themes indicated that lessons learned in the promotion of informal learning spaces focused on STEAM in the public library focused on 10 areas:

- meet the needs of the community,
- the library needs to embrace STEAM,
- research and program with achievement gaps in mind,
- evaluate the internal capacity of staff,
- communicate the plan for STEAM program ideas,
- investigate and know what the trends are in STEAM,
- communicate and substantiate staff needs to operate the program,
- perform an assessment of the potential space prior to planning the programs,
- training staff for STEAM,
- consider future growth and skill sets needed, and
- a STEAM program is possible in any size library.

**Discussion of research question 4.** Chapter 1 speaks to the changing roles of libraries in the community (Mattern, 2014) and the continued threats of budget cuts (Child & Goulding, 2012). The library and continued STEAM efforts provide some measure for addressing the how and why of continued buzz over science in the public library. One element of success is meeting the needs of the community. P11 adamantly spoke of how her programs thrived by simply asking the community what they wanted, not what she perceived the community to want. The lesson learned involved traditional approaches to service, however with a greater sense of urgency. As the library and staff embraced STEAM, they addressed feelings of intimidation. As the library

continued to reimagine its space, staff made themselves aware of the gaps in knowledge by doing research, connecting with the area schools, and collaborating on curriculum needs. With the growth in programs, a need for professional development of staff beyond the traditional roles was expressed, so the STEAM leader had assistance but was also creating leverage with the sharing of institutional knowledge. Last, the general consensus for lesson learned included what P8 said, “start simple” and “be intentional.” P9 said, “Do not get caught up in buying stuff.”

### **Implications of the Study**

The purpose of this study was to explore best practices for the implementation of STEAM programs in a public library system and to advance informal learning opportunities within public spaces. The research aimed to identify challenges and obstacles that librarians face in leading effective implementation. As the public library continues to evolve amid ever-changing technological advances, identifying the components that make up the prescription for success for this public institution is necessary. Fundamentally, this research looked beyond the obstacles and challenges and identified the strategies that best help maneuver the difficulties that sometimes stifle success in public libraries. Ultimately, this research provides a model of success that other librarians can employ to help them lead an implementation that delivers effective and efficient informal learning opportunities for its users, as well as provide some strategic methodologies for molding a fluid model that encompasses STEAM. The efforts of employing STEAM programs also require a deep assessment of existing functions and the needs for future improvements. Once librarians have truly assessed the needs and desires of the community and make a concerted effort to meet those needs, existing models will require honest discussion and a meeting of the minds for some librarians who have found STEAM to be intimidating and



relinquishing traditional roles of the profession daunting if the library is to remain relevant in and to the community it serves.

As such, the findings of this study can be used by public libraries to develop or revise strategies that incorporate the proven best practices identified in the study. The represented sample of public libraries are indeed libraries that have embraced cutting edge service models by listening and accepting the support of the community. In addition, public organizations can use the findings to develop future STEAM leadership training, manuals, and programs that are based on the successes and lessons learned by those currently in lead positions for STEAM implementation. Last, the findings can be used to develop collaborative efforts across districts, states, and national organizations facilitating STEAM initiatives.

### **Study Conclusion**

The researcher began this study with the desire to add to the existing body of literature on public libraries by seeking exemplary leaders of STEAM program efforts and identifying best practices that make the programs successful. To accomplish this task, the researcher bracketed her biases and perspectives as a librarian and as an employee of a library system. Through the process of 11 interviews, the researcher was able to code and analyze nine open-ended interview questions that informed four research questions, all designed to identify the challenges faced and best practices STEAM leaders use in their roles as lead instructors in planning design, implementation, and post implementation to understand what makes the programs successful. As a result, eight findings were identified:

1. Pedagogy on the integration of STEM/STEAM specific job title descriptors that quantify the needed skill sets for leading such an initiative is lacking. Therefore, libraries as whole have to develop strategies for the integration of experts in STEAM fields and or

educators who inherently have experience in the foundational knowledge of the five areas: science, technology, engineering, art, and math. The participants in the survey included five persons with prior professional experience in the areas teaching, instructing, science, and media who lead noted STEAM programs in urban and suburban communities in the United States. The remaining participants were career librarians who exemplified a wide range of experience within the field and an in-depth relationship with local, county, and national STEAM efforts.

2. Governing bodies on the national, state, and local levels need to strategically decide on enforcing STEAM or not so that the city and county public libraries can establish collaborative relationships across borders. Three of the participants have developed partnerships with other higher educational entities that provide support in the areas of funding and collaborative efforts to support youth-serving organizations and learning to provide visibility of resources that support youth development.

3. An assessment tool needs to be developed to assist libraries with deep, investigative methodologies on design with growth or expansion, or not, as an option.

4. A guiding tool needs to be developed to assist libraries in forging deep, long-term partnerships with learning organizations that have the expertise as well as theory to assist in providing support for evaluation that leads to a presence in the literature on STEAM in public libraries.

5. The American public library needs to be recognized as a learning support organization with emphasis on informal learning practices in every community by the ALA, the leading national association for the development of libraries.

6. The public library needs to rethink its service initiative and allow flexibility and full autonomy to fulfill the needs of the community.
7. Pay scales for libraries need to be reestablished that focus on job readiness and apprenticeship programs.
8. Strategies need to be developed that create value and add methods of sustainability in staff retention and teen retention by incentivizing volunteerism and employment for teen experts.
9. Public libraries with STEAM initiatives need a database that can be shared as a resource for guidance in the establishment of a STEAM program.

### **Recommendation for Future Research**

The purpose of the study was to determine best practices that libraries employ to make them successful in leading informal learning in the area of STEAM. Future researchers can contribute to the existing body of knowledge by conducting studies that focus on:

1. a study that focuses on the long-term effects of informal learning experiences in public libraries and the correlation with school performance,
2. a study that investigates and measures the career pathways of students who elect to participate in STEAM programs over a defined length of time,
3. a study that postulates the public library as a recognized learning institution and an apprenticeship program for the general public,
4. a study that investigates the effects of economic stability of students who elect to participate in long-term STEAM programs at the public library throughout high school, and

5. a comparative analysis of reading interest in STEAM participants versus non-participants and career paths taken.

## **Final Thoughts**

In 1917, Arthur Elmore Bostwick authored the book *The American Public Library*, in which he spoke of the broadening of the library idea and the ramification of such that caused a dynamic shift in library services. These services were vastly different and not well received, even by librarians. Yet again, we are broadening the ideas of the library with technological advances that have proven to be disruptive and are again forcing librarians to reimagine service, relationships, and skill sets. The interception of public libraries and informal learning in the areas of science, technology, the arts, engineering, and math has proven to be a desire of the general public and one that will assist future generations in their ideals of democracy and service. This study sought to identify the best practices that current leaders in STEAM have employed in the public library. As a result, the study identified collaborative involvement, the promotion of innovative learning, dynamic development through programs, career pathways, structures strategies, and access and equity as valuable strategies and practices to foster success in public libraries.

## REFERENCES

- A look at the history of STEM (and why we love it). (2016, May 16). Marick Group. Retrieved from <http://marickgroup.com/news/2016/a-look-at-the-history-of-stem-and-why-we-love-it>
- Afterschool Alliance. (2015). Full STEM ahead: Afterschool programs step up as key partners in STEM education. Retrieved from <http://www.afterschool.org /AA3PM/STEM.pdf>
- ALA Office for Research and Study. (2011). *Public libraries and the Internet*. Chicago, IL: American Library Association.
- Allen, S., Gutwill, J., Perry, D. L., Garibay, C., Ellenbogen, K. M., Heimlich, J. E., & Klein, C. (2007). Research in museums: Coping with complexity. In J. H. Falk, L.D. Dierking, S. Foutz, & D. A. Ucko (Eds.), *In principle, in practice: Museums as learning institutions* (pp. 229-245). Lanham, MD: AltaMira.
- Anderton, H. (2012). STEM, teens, and public libraries: It's easier than you think! Questia.com. Retrieved from <https://www.questia.com/library/journal/1G1-280719543/stem-teens-and-public-libraries-it-s-easier-than>
- Andrew Carnegie's story. (2015). Retrieved from <https://www.carnegie.org/interactives/foundersstory/#!/>
- Araque, J. A., Maiden, R., Bravo, N., Estrada, I., Evans, R., Hubchik, K., & Reddy, M. (2013). Computer usage and access in low-income urban communities. *Computers in Human Behavior*, 29(4), 1393-1401. <https://doi.org/10.1016/j.chb.2013.01.032>
- Arnd-Michael, N. (2010). In R. Bohnsack, N. Pfaff & Weller, *Qualitative analysis and documentary* (pp. 195-217). Opladen: B. Budrich. Retrieved from <http://nbn-resolving.de/urn:nbn:de:0168-ssoar-317517>

- Awason, I. (2015). Research methods for STEM librarians: Perspectives from a narrative inquiry angle. Retrieved from <https://rc.library.uta.edu/uta-ir/handle/10106/25855>
- Baek, J. (2013). Public libraries as places for STEM Learning: An exploratory interview study with eight librarians. Retrieved from [http://www.nc4il.org/images/papers/Baek\\_Public%20Libraries%20as%20Places%20for %20STEM%20Learning.pdf](http://www.nc4il.org/images/papers/Baek_Public%20Libraries%20as%20Places%20for%20STEM%20Learning.pdf)
- Bailey, D., Wyld, J., Falk, J., Dierking, L., Staus, N., & Penuel, W. (2016). Taking an ecosystem approach to STEM learning: Connected science learning. Retrieved from <http://csl.nsta.org/2016/03/taking-an-ecosystem-approach/>
- Bannon, B. (2012). YOUmedia Chicago: Connecting youth through public libraries. *National Civic Review*, 101(4), 33-35. <http://dx.doi.org/10.1002/ner.21103>
- Bates, M. J. (1986). Subject access in online catalogs: A design model. *Journal of the American Society for Information Science*, 37(6), 357-376. Retrieved from [http://dx.doi.org/10.1002/\(SICI\)1097-4571\(198611\)37:6<357::AID-ASII>3.0.CO;2-H](http://dx.doi.org/10.1002/(SICI)1097-4571(198611)37:6<357::AID-ASII>3.0.CO;2-H)
- Beatty, A. (2011). *Successful STEM education*. Washington, DC.: National Academies Press. <https://doi.org/10.17226/13230>
- Bekerman, Z., Burbules, N., & Silberman-Keller, D. (2006). *Learning in places* (1st ed.). New York, NY: Peter Lang. Retrieved from <https://doi.org/10.1111/j.1548-1492.2010.01070.x>
- Belkin, N. J., Oddy, R. N., & Brooks, H. M. (1982). Ask for information retrieval: Part I. Background and theory. *Journal of Documentation*, 38(2), 61-71. <http://dx.doi.org/10.1108/eb026722>

- Bell, P., Lewenstein, B., Shouse, A., & Feder, M. (2009). *Learning science in informal environments*. Washington, DC: National Academies Press.
- Bernard, H. R. (2002). *Research methods in anthropology: Qualitative and quantitative approaches* (3rd ed.). Walnut Creek, CA: Alta Mira Press.
- Berube, L. (2005). E-books in public libraries: A terminal or termination technology? *Interlending & Document Supply*, 33(1), 14-18. doi:10.1108/02641610510582090.
- Best, J. W., & Kahn, J. V. (2006). *Research in education*. Boston, MA: Pearson Education, Inc.
- Blackler, F. (1993). Knowledge and the theory of organizations: Organizations as activity systems and the reframing of management. *Journal of Management Studies*, 30(6): 863-884.
- Block, P. (2008). *Community: The structure of belonging*. San Francisco, CA: Berrett-Koshler Publishers, Inc.
- Boelter, C., Link, T. C., Perry, B. L., & Leukefeld, C. (2015). Diversifying the STEM pipeline. *Journal of Education for Students Placed at Risk*, 20(3), 218-237.
- Bohm, D. (1996). *On dialogue*. New York, NY: Routledge.
- BookNet Canada reports on Canadian 2016 print book sales. (2017). *Seybold Report: Analyzing Publishing Technologies*, 17(3), 6-12.
- Bostwick, A. (1917). *The American public library* (1st ed.). New York, NY: Appleton.
- Britton, L. (2012). The making of maker spaces. *Library Journal*, 137(16), 20.
- Brogan, J. (2015, November 10). "The library's global future." *Slate Online Magazine.*, 1-2,  
Retrieved from  
[http://www.slate.com/articles/technology/future\\_tense/2015/11/libraries\\_are\\_changing\\_international\\_development.html](http://www.slate.com/articles/technology/future_tense/2015/11/libraries_are_changing_international_development.html)

- Brown, J., & Peterson, J. (2013, June 28). STEM Ed Coalition statement on Senate passage of Immigration Bill. *STEM Education Coalition*. Retrieved from <http://www.stemedcoalition.org/2013/06/28/stem-ed-coalition-statement-on-senate-passage-of-immigration-bill/>
- Brown, M., & Long, P. (2006). Trends in learning space design. In D. Oblinger (Ed.), *Learning spaces* (pp. 1-2). Washington, DC: EDUCAUSE.
- Bryman, A. (1988). *Quantity and quality in social research*. London, UK: Unwin Hyman.
- Bureau of Labor Statistics (2014). STEM 101: Intro to tomorrow's jobs. <http://www.bls.gov/careerout-look/subjects/stem.htm>
- Buschman, J. E., & Leckie, G. E. (2007). *The library as place: History, community, and culture*. Westport, CT: Libraries Unlimited.
- Camera, L. (2017, May 25). Low-income students nowhere to be found in STEM: A dearth of low-income students in STEM has college officials "terrified." *U.S. News & World Report*. Retrieved from <https://www.usnews.com/news/stem-solutions/articles/2017-05-25/low-income-students-nowhere-to-be-found-in-stem>
- Carcary, M. (2009). The research audit trial – Enhancing trustworthiness in qualitative inquiry. *The Electronic Journal of Business Research Methods*, 7(1), 11-24.
- Carlson, E., & Goss, J. (2016). The state of the urban/rural digital divide. *National Telecommunications and Information Administration*. Retrieved from <https://www.ntia.doc.gov/blog/2016/state-urbanrural-digital-divide>
- Chadwell, F. A. (2010). What's next for collection management and managers? *Collection Management*, 35(2), 59-68. <https://doi.org/10.1080/01462671003620199>



- Chadwick, C., DiPilato, R., le Conge, M., Rubin, R., & Shaffer, G., (2012, October 26). The future of the FDLP in public libraries. *Public Libraries Online*. Retrieved from <http://publiclibrariesonline.org/2012/10/the-future-of-the-fdlp-in-public-libraries/>
- Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, 6, 49. <http://doi.org/10.3389/fpsyg.2015.00049>
- Child, R., & Goulding, A. (2012). Public libraries in the recession: The librarian's axiom. *Library Review*, 61(8/9), 641-663. doi:10.1108/00242531211292123.
- Clark, J. (2015). Library as place: What students value in a performing arts library. *Music Reference Services Quarterly*, 18(3-4), 139-156. doi:10.1080/10588167.2015.1093882
- Closing the achievement gap in math and science. (2008). Retrieved from [https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=111514](https://www.nsf.gov/news/news_summ.jsp?cntn_id=111514)
- Cochran, T. (2011). *Frontiers of change*. New York, NY: Oxford University Press.
- Code.org: Anybody can learn. (2017). Retrieved from <https://code.org>
- Coffield, F. (2000). *The necessity of informal learning*. Bristol, UK: Policy Press.
- Cohen, D., & Crabtree, B. (2006). Qualitative research guidelines project. Retrieved from <http://www.qualres.org/HomeEval-3664.html>
- Cohen, W. (1975). Lifelong learning: A definition and a challenge. *Educational Leadership*, 33(2), 83. Retrieved from <https://doi.org/10.1080/096452998000000021>
- Cohn, E., & Addison, J. T. (1998). The economic returns to lifelong learning in OECD countries. *Education Economics*, 6(3), 253.
- Cohron, M. (2015). The continuing digital divide in the United States. *The Serials Librarian*, 69(1), 77-86. doi:10.1080/0361526x.2015.1036195

- Collie, V. (2013, March 8). Reconsidering our core values. *Public Libraries Online*. Retrieved from <http://publiclibrariesonline.org/2013/03/reconsidering-our-core-values>
- Collins, L., & Somerville, M. (2008). Collaborative design: A learner-centered library planning approach. *The Electronic Library*, 26(6), 803-820. doi:10.1108/02640470810921592.
- Coombs, P., & Ahmed, M. (1974). *Attacking rural poverty: How nonformal education can help*. (Research Report). Baltimore, MD: Johns Hopkins University Press.
- Coppola, G. (2010). Library as the third place. *Florida Libraries*, 53(2), 14-15.
- Cotten, S. R., Davison, E., Shank, D., & Ward, B. (2014). Gradations of disappearing digital divides among racially diverse middle school students. In *Series in media and communication: Vol. 8. Communication and information technologies annual 2014: Doing and being digital-mediated childhoods* (pp. 25-53). Bingley, UK: Emerald Press.
- Creswell, J. W. (1998). *Qualitative inquiry and research design*. Thousand Oaks, CA: Sage Publications.
- Creswell, J. W. (2003). *Research design: quantitative, and mixed methods approaches* (2<sup>nd</sup> ed.). Thousand Oaks, CA: Sage Publications.
- Creswell, J. W. (2005). *Educational research, planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson Education.
- Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2<sup>nd</sup> ed.). Thousand Oaks, CA: Sage Publications.
- Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Los Angeles, CA: Sage Publications.

- Cummings, R., Neatrou, A., & Callaway, E. (2018, February). Future/death of the library: A collaborative topic modeling project (Paper session). Retrieved from <https://digitalcommons.usu.edu/dhu3/2018/session22018/1/>
- Dagley, M., Georgiopoulos, M., Reece, A., & Young, C. (2015). Increasing retention and graduation rates through a STEM learning community. *Journal of College Student Retention: Research, Theory & Practice*, 18(2), 167-182.  
<http://dx.doi.org/10.1177/1521025115584746>
- Declaration for the right to libraries. (2013, October 3). American Library Association. Retrieved from <http://www.ala.org/advocacy/2017>.
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (1998). *The SAGE handbook of qualitative research*. Thousand Oaks, CA: Sage Publications.
- Dervin, B., & Nilan, M. (1986). Information needs and uses. *Annual review of information & technology*, 21(1), 3-33.
- Developing the STEM education pipeline. (2006). ACT, Inc. Retrieved from <https://files.eric.ed.gov/fulltext/ED493179.pdf>
- Dewe, M. (2017). *Planning public library buildings*. Abingdon, UK: Routledge.
- Digital Inclusion Survey. (2013, August 28). American Library Association. Retrieved from <http://www.ala.org/tools/research/digitalinclusion>
- DiMaggio, P., Hargittai, E., Neuman, W. R., & Robinson, J. P. (2001). Social implications of the Internet. *Annual Review of Sociology*, 27(1), 307-336.
- Douglas, J. D. (1970). *Understanding everyday life*. Chicago, IL: Aldine.
- Drew, D. E. (2011). *STEM the tide: Reforming science, technology, engineering, and math education in America*. Baltimore, MD: Johns Hopkins University Press.

- Drori, G. S. (2000). Science education and economic development: Trends, relationships, and research agenda. *Studies in Science Education*, 35(1), 27-57.  
<https://doi.org/10.1080/03057260008560154>
- Dusenbery, P. B. (2014). The STEM education movement in public libraries. *Informal Learning Review*, 124, 14-19.
- Education and continuous learning. (2007, April 19). American Library Association. Retrieved from <http://www.ala.org/aboutala/missionhistory/keyactionareas/educationaction/educationcontinuing>
- Edwards, B. (2009). *Libraries and learning resource centres*. Oxford, UK: Architectural Press.
- Elmborg, J. (2016). Tending the garden of learning: Lifelong learning as core library value. *Library Trends*, 64(3), 533-555. doi:10.1353/lib.2016.0009
- Erickson, I., Meyers, E., & Small, R. (2013). Digital literacy and informal learning environments: An introduction. *Learning, Media and Technology*, 38(4), 355-367.  
doi:10.1080/17439884.2013.783597
- Every student succeeds act. (2015). U.S. Department of Education. Retrieved from <https://www.ed.gov/essa>
- Fact sheet: At White House science fair, President Obama calls on this generation of students to tackle the grand challenges of our time. (2016). Retrieved from <https://obamawhitehouse.archives.gov/the-press-office/2016/04/13/fact-sheet-white-house-science-fair-president-obama-calls-generation>

- Fallows, J. (2016, June). Why the maker movement matters: Part 1, the tools revolution. *The Atlantic*. Retrieved from <https://www.theatlantic.com/business/archive/2016/06/why-the-maker-movement-matters-part-1-the-tools-revolution/485720/>
- Fayer, Stella A. (2017). Science, technology engineering and mathematics (STEM) occupations: past, present and future: Spotlight on Statistics: U.S. Bureau of Labor Statistics. Retrieved from <https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/home.htm>
- Feder, M., Shouse, A., Lewenstein, B., & Bell, P. (Eds.). (2012). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: The National Academies Press.
- Freeman, G. (2017). *The library as place: Rethinking roles, rethinking space*. Washington, DC: Council of Library and Information Resources.
- Funk, C., & Hefferon, M. (2018). As the need for highly trained scientists grows, a look at why people choose these careers. Retrieved from <http://www.pewresearch.org/fact-tank/2016/10/24/as-the-need-for-highly-trained-scientists-grows-a-look-at-why-people-choose-these-careers/>
- Galletta, A. (2012). *Mastering the semi-structured interview and beyond: From research design to analysis and publication*. New York, NY: University Press.
- Gangopadhyay, P. (2017, June 28). Coming together to inspire underserved youth with STEM learning through making. *Institute of Museum and Library Services*. Retrieved from <https://www.imls.gov/blog/2017/06/coming-together-inspire-underserved-youth-stem-learning-through-making>

- Garmer, A. K. (2014). Rising to the challenge: Re-envisioning public libraries. *The Aspen Institute*. Retrieved from <http://csreports.aspeninstitute.org/documents/Aspen-LibrariesReport-2017-FINAL.pdf>
- Garrick, J. (1998). Informal learning in corporate workplaces. *Human Resource Development Quarterly*, 9(2), 129-144.
- Geiger, A. (2017, June). Millennials are the most likely generation of Americans to use public libraries. *Pew Research Center*. Retrieved from <http://www.pewresearch.org/fact-tank/2017/06/21/millennials-are-the-most-likely-generation-of-americans-to-use-public-libraries/>
- Gerding, S. (2011). Chapter 7: Transforming Public Library Patron Technology Training. Retrieved from <https://journals.ala.org/index.php/ltr/article/view/4550/5346>
- Gilbert, M. (2010). Theorizing digital and urban inequalities: Critical geographies of “race,” gender and technological capital. *Information, Communication & Society*, 13(7), 1000-1018. <https://doi.org/10.1080/1369118X.2010.499954>
- Gilton, D. L. (2012). *Lifelong learning in public libraries: Principles, programs, and people*. Lanham, MD: Scarecrow Press.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. Chicago, IL: Aldine Publishing Company.
- Goldberg, R. (2016, January 13). Data preview: What's new in the July 2015: CPS Computer and Internet Use Supplement. National Telecommunications and Information Administration. Retrieved from <https://www.ntia.doc.gov/blog/2016/data-preview-whats-new-july-2015-cps-computer-and-internet-use-supplement>.

- Gonzales, A. (2015). The contemporary U.S. digital divide: From initial access to technology maintenance. *Information, Communication & Society*, 19(2), 234-248.  
doi:10.1080/1369118x.2015.1050438
- Gonzales, A. G. (2017). Disadvantaged minorities' use of the Internet to expand their social networks. *Communication Research*, 44(4), 467-486.
- Gonzalez, H. B., & Kuenzi, J. J. (2012). Science, technology, engineering, and mathematics (STEM) education: A primer. Congressional Research Service. Retrieved from <http://pepperdine.worldcat.org/oclc/806032750>
- Graf, N., Fry, R., & Funk, C. (2018, January 9). Seven facts about the STEM workforce. *Pew Research Center*. Retrieved from <http://www.pewresearch.org/fact-tank/2018/01/09/7-facts-about-the-stem-workforce/>
- Groff, J. (2013). Technology-rich innovative learning environments. Retrieved from <http://www.oecd.org/education/ceri/Technology-Rich%20Innovative%20Learning%20Environments%20by%20Jennifer%20Groff.pdf>
- Gross, V. (2013). *Transforming our image, building our brand*. Santa Barbara, CA: Libraries Unlimited.
- Gunkel, D. J. (2003). Second thoughts: Toward a critique of the digital divide. *New Media & Society*, 5(4), 499-522.
- Hakala, J. S., MacCarthy, K., Dewaele, C., Wells, M., Dusenbery, P. B., & LaConte, K. (2016). STEM in public libraries: National survey results. *STAR Net*. Retrieved from [http://www.nc4il.org/images/papers/FINAL\\_STEM\\_LibrarySurveyReport.pdf](http://www.nc4il.org/images/papers/FINAL_STEM_LibrarySurveyReport.pdf)

- Harrop, D., & Turpin, B. (2013). A study exploring learners' informal learning space behaviors, attitudes, and preference. *New Review of Academic Librarianship*, 19(1), 57-77. doi:10.1080/13614533.2013.740961
- Hein, S., & Austin, W. (2001). Empirical and hermeneutic approaches to phenomenological research in psychology: A comparison. *Psychological Methods*, 6(1), 3-17. doi:10.1037//1082-989x.6.1.3
- Hoffman, K. E. (1998, November 9). Internet as gender-equalizer. *Internet World*, 4(37), 32.
- Holman, W. (2015, November). Makerspace: Towards a new civic infrastructure. *Places Journal*. Retrieved from <https://placesjournal.org/article/makerspace-towards-a-new-civic-infrastructure/?gclid=CN7Iv7K5zMkCFdRuGwodO-IAxw>
- Holmes, E. (2006). Google and beyond: Finding information using search engines, and evaluating your results. Retrieved from <https://digitalcommons.law.uga.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1001&context=speeches>
- Holton, E., & Swanson, R. (2010). *Foundations of human resource development*. San Francisco, CA: Berrett-Koehler Publishers.
- Hom, E. (2014, February 14). What is STEM Education? *Live Science*. Retrieved from <https://www.livescience.com/43296-what-is-stem-education.html>
- Horrigan, J. B. (2016a, September 9). Libraries 2016. *Pew Research Center*. Retrieved from <http://www.pewinternet.org/2016/09/09/libraries-2016/>
- Horrigan, J. B. (2016b, September 20). Digital readiness gaps. *Pew Research Center*. Retrieved from <http://www.pewinternet.org/2016/09/20/digital-readiness-gaps/>



- Howe, N., Matson, R. J., & Strauss, W. (2000). *Millennials rising: The next great generation*. New York, NY: Vintage Books.
- Hurtado, S., Newman, C. B., Tran, M. C., & Chang, M. J. (2010). Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project. *New Directions for Institutional Research*, 2010(148), 5-15. doi:10.1002/ir.35
- Institute of Museum and Library Services. (2017). *Focus summary report: Learning in the library*. Washington, DC: IMLS.
- Issues and trends. (2015, April 2). American Library Association. Retrieved from <http://www.ala.org/news/state-americas-libraries-report-2015/issues-and-trends>.
- Ito, M., & Martin, C. (2013). Connected learning and future of libraries. *Young Adult Library Services*, 12(1), 29.
- Ives, B. (1993). Ramping up to the U.S. national data highway. *MIS Quarterly*, 17(2), xxxv.
- Jakubowski, R., Riendeau, L., & Shtivelband, A. (2017). Building upon the STEM movement: Programming recommendations for library professionals. *Children and Libraries*, 15(4), 23. doi:10.5860/cal.15.4.23
- Janesick, V. (2016). *"Stretching" exercises for qualitative researchers*. Los Angeles, CA: Sage Publications.
- Kafai, Y., Peppler, K., & Chapman, R. (2009). *The computer clubhouse*. New York, NY: Teachers College Press.
- Kern, S. (2003). *The culture of time and space, 1880-1918*. Cambridge, MA: Harvard University Press.

- Kier, M., Blanchard, M., Osborne, J., & Albert, J. (2013). The development of the STEM career interest survey (STEM-CIS). *Research in Science Education*, 44(3), 461-481.  
<http://dx.doi.org/10.1007/s11165-013-9389-3>
- Kim, B. (2005). *Internationalizing the internet: The co-evolution of influence and technology*. Cheltenham, UK: Edward Elgar Publishing.
- Kinney, B. (2010). The Internet, public libraries, and the digital divide. *Public Library Quarterly*, 29(2), 101-161. doi:10.1080/01616841003779718
- Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research*. Beverly Hills, CA: Sage Publications.
- Knowles, M. S. (1950). *Informal adult education*. New York, NY: Associated Press.
- Koehler, N. (2015). Discipline-specific knowledge and capabilities. *Deakin Learning Futures*. Retrieved from <http://teachassist.deakin.edu.au/wp-content/uploads/2015/06/GLO1-discipline-specific-knowledge-capabilities.pdf>
- Kurzweil, R. (1992). The future of libraries, part 2: The end of books. *Library Journal*, 117(3), 140.
- Kvale, S., & Brinkman, S. (2009). *Interviews: Learning the craft of research interviewing* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- LaConte, K., & Dusenbery, P. (2016). STEM learning in public libraries: New perspectives on collaboration from a national conference. Retrieved from <http://www.nc4il.org/images/papers/LaConte-Dusenbery-ILR-140-2016.pdf>
- Landivar, L. (2013). Disparities in STEM employment by sex, race, and Hispanic origin. *Education Review*, 29(6), 911-922. Retrieved from <https://www.census.gov/prod/2013pubs/acs-24.pdf>

- Larsen, A. (2017). *The man who loved libraries*. Berkley, CA: Owlkids Books, Inc.
- Leadbeater, C. (2000). *Living on thin air* (1st ed.). London, UK: Penguin.
- Lee, J. (2009, March). DIY learning shelves teachers. *TES*, (4832), 3.
- Lee, S. (2007). *Print vs. digital*. New York, NY: Haworth Press.
- Lecompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research*, 52(1), 31-60.  
doi.org/10.3102/00346543052001031
- Leedy, P., & Ormrod, J. (2005). *Practical research*. Upper Saddle River, NJ: Prentice Hall.
- Lemke, J., Lecusay, R., Cole, M., & Michalchik, V. (2012). Documenting and assessing learning in informal and media-rich environments: A report to the MacArthur Foundation. Retrieved from [http://tclearninglounge.org/robert/design-informal-science-practicum-WI13/readings/MACARTHUR\\_informal\\_learning\\_draft.pdf](http://tclearninglounge.org/robert/design-informal-science-practicum-WI13/readings/MACARTHUR_informal_learning_draft.pdf)
- Lettvin, E. (2015). Engagement, creativity and inspiration found in new afterschool STEM programs. Office of Innovation and Improvement. Retrieved from <https://sites.ed.gov/oii/2015/04/stem-programs-at-the-department-of-education-supporting-teachers-and-students-2/#more-3643>
- Levien, R. E. (2011). Confronting the future: Strategic visions for the 21st century public library. *Foresight for Development*. Retrieved from <http://www.foresightfordevelopment.org/sobipro/55/463-confronting-the-future-strategic-visions-for-the-21st-century-public-library>
- Library as place: Rethinking roles, rethinking space. (2012, October 31). American Library Association. Retrieved from <http://www.ala.org/tools/librariestransform/library-place-rethinking-roles-rethinking-space>.

- Libraries support digital readiness with tech training, STEM programs, more robust online collections. (2014, July 22). American Library Association. Retrieved from <http://www.ala.org/news/press-releases/2014/07/libraries-support-digital-readiness-tech-training-stem-programs-more-robust>.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.
- Little, G. (2011). The book is dead: Long live the book! *Journal of Academic Librarianship*, 37(6), 536-538.
- Livni, E. (2017, July 29). Millennials are the ones keeping libraries alive. *Quartz*. Retrieved from <https://qz.com/1039294>
- Lowry, P. (2003, March 2). Carnegie's library legacy: The Carnegie struggles with honoring The past while serving the present and future. *Post-Gazette*. Retrieved from <http://old.post-gazette.com/ae/20030302carnegie2.asp>
- Marshall, C., Mandel, B., & Minkel, W. (2004). Morse code. *School Library Journal*, 50(4), 68.
- Marshall, C., & Rossman, G. (2016). *Designing qualitative research*. Los Angeles, CA: Sage Publications.
- Marsick, V. J., & Watkins, K. E. (2001). Informal and incidental learning. *New Directions for Adult & Continuing Education*, 2001(89), 25-34.
- Martin, L. (1937). The American public library as a social institution. *The Library Quarterly: Information, Community, Policy*, 7(4), 546-563. Retrieved from <http://www.jstor.org/stable/4302405>
- Mattern, S. (2014, June). Library as infrastructure. *Places Journal*. Retrieved from <https://doi.org/10.22269/140609>

- Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- McClure, C. R., Bertot, J. C., & Zweizig, D. (1994). *Public libraries and the Internet: Study results, policy issues, and recommendations*. Washington, DC: United States National Commission on Libraries and Information Science. Retrieved from <http://www.plinternetsurvey.org>.
- McComas, W. F. (2014). Benchmarks for science literacy. In W. F. McComas (Ed.), *The language of science education* (pp. 1-12). doi.org/10.1007/978-94-6209-497-0\_11
- McConnaughey, J. W., & Lader, W. (1998, July 28). Falling through the net II: New data on the digital divide. *National Telecommunications and Information Administration*. Retrieved from <https://www.ntia.doc.gov/report/1998/falling-through-net-ii-new-data-digital-divide>
- McLoughlin, C., & Lee, M. J. W. (2008). Future learning landscapes: Transforming pedagogy through social software. *Innovate: Journal of Online Education*, 4(5), 1. Retrieved from <https://nsuworks.nova.edu/innovate/vol4/iss5/1>
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2<sup>nd</sup> ed.). Thousand Oaks, CA: Sage Publications.
- Morehart, P. (2015). The future, today. *American Libraries*, 46(3/4), 42-45. Retrieved from <https://americanlibrariesmagazine.org/2015/02/26/the-future-today/>
- Moustakas, C. (1995). *Phenomenological research methods*. Thousand Oaks, CA: Sage Publications.
- Nager, A., Ezell, S., Cory, N., & Ezell, S. (2015). What Creates Jobs? Welcoming STEM Workers. The Innovation Files. Retrieved from <https://www.innovationfiles.org/what-creates-jobs-welcoming-stem-workers/>

National Academy of Engineering. (2008). *Grand challenges for engineering*. Washington, DC: The National Academies.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: National Academies Press.

National Academies of Sciences, Engineering, and Medicine. (2016). *Developing a national STEM workforce strategy: A workshop summary*. Washington, DC: National Academies Press. <https://doi.org/10.17226/21900>

National Research Council. (2002). *Learning and understanding: Improving advanced study of mathematics and science in U.S. high schools*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/10129>.

National Research Council. (2011). *Successful STEM education: A workshop summary*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13230>.

National Science Board. (2014). *Science and engineering indicators 2014*. NSB 14-01. Arlington, VA: National Science Foundation. Retrieved from <http://www.nsf.gov/statistics/seind14/content/etc/nsb1401.pdf>.

National Telecommunications and Information Administration. (1999). *How access benefits children: Connecting our kids to the world of information*. Washington DC: National Telecommunications and Information Administration. Retrieved from <https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED462977>.

National Telecommunications and Information Administration. (2017). Retrieved from <http://ntia.doc.gov>

- Nielsen, B. G. (2014). Public libraries and lifelong learning. *Perspectives of Innovations, Economics and Business*, 14(2), 94-102. doi:10.15208/pieb.2014.11
- Nishi, J. (2011). Opportunity for all: How the American public benefits from internet access at U.S. libraries: A study from the Bill & Melinda Gates Foundation and the Institute of Museum and Library Services. *National Civic Review*, 100(3), 36-40.  
doi:10.1002/ncr.20071
- Nohl, A. M. (2010). Narrative interview and documentary interpretation. In R. Bohnsack, N. Pfaff, & W. Weller (Eds.), *Qualitative analysis and documentary method in international educational research* (pp. 195-218). Ophaden & Farmington Hills, MI: Barbara Budrich Publishers.
- Number of libraries in the United States. (2006, July 7). American Library Association.  
Retrieved from <http://www.ala.org/tools/libfactsheets/alalibraryfactsheet01>
- Oblinger, D. (2006). *Learning spaces*. Washington, DC: EDUCAUSE.
- Omdal, S., Richards, M., Brennan, D., & Gonzales, J. (2006). *STEMming the tide: A Colorado response to the national crisis in STEM education*. Parker, CO: The Colorado Association for Gifted and Talented. Retrieved from  
<http://www.coloradogifted.org/images/documents/WhitePaperFinal.pdf>
- Pacios, A. (2007). The priorities of public libraries at the onset of the third millennium. *Library Management*, 28(6/7), 416-427. <http://dx.doi.org/10.1108/01435120710774549>
- Parker, K. (2015, January 13). Millennials are redefining what adulthood means. *The New York Times*. Retrieved from <https://www.nytimes.com/roomfordebate/2014/12/25/is-it-smart-to-delay-adulthood/millennials-are-redefining-what-adulthood-means>

- Patton, M. Q. (2002). *Qualitative research and evaluation methods*. (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Thousand Oaks, CA: Sage Publications.
- Penuel, W. R., Clark, T. L., & Bevan, B. (2016). Infrastructures to support equitable STEM learning across settings. *Afterschool Matters*, (24), 12-20. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1120471.pdf>
- Poe, M. (2011). *A history of communications: Media and society from the evolution of speech to the Internet*. New York, NY: Cambridge University Press.
- Polkinghorne, D. E. (1989). Phenomenological research methods. In R. S. Valle & S. Halling (Eds.), *Existential-phenomenological perspectives in psychology* (pp. 41–60). New York, NY: Plenum.
- Powell, A. (2007, October 11). How Sputnik changed U.S. education. *The Harvard Gazette*. Retrieved from <http://news.harvard.edu/gazette/story/2007/10/how-sputnik-changed-u-s-education/>
- Presidential committee on information literacy: Final report. (2006, July 24). American Library Association. Retrieved from <http://www.ala.org/acrl/publications/whitepapers/presidential>.
- Public libraries. (2009, August 5). American Library Association. Retrieved from <http://www.ala.org/tools/research/librарystats/public>



Public libraries lead the way to digital inclusion. (2014, July 23). American Library Association. Retrieved from <http://www.ala.org/aboutala/offices/ors/public-libraries-lead-way-digital-inclusion>.

Public wants libraries to advance education, improve digital literacy and serve key groups. (2015). Retrieved from [http://www.pewinternet.org/2015/09/15/libraries-at-the-crossroads/2015-09-15\\_libraries\\_0-01/](http://www.pewinternet.org/2015/09/15/libraries-at-the-crossroads/2015-09-15_libraries_0-01/)

Pundsack, K. (2016). 2014 digital inclusion survey report: Public libraries as basic community technology infrastructure. *Public Libraries Online*. Retrieved from <http://publiclibrariesonline.org/2016/01/2014-digital-inclusion-survey-report-public-libraries-as-basic-community-technology-infrastructure/>

Pungitore, V. (1995). *Innovation and the library*. Westport, CT: Greenwood Press.

Rainie, L. (2014a, April 9). Millennials and libraries. Pew Research Center. Retrieved from <http://www.pewinternet.org/2014/04/09/millennials-and-libraries/>

Rainie, L. (2014b, April 10). The future of libraries: Seven questions librarians need to answer. *Pew Research Center*. Retrieved from <http://www.pewinternet.org/2014/04/10/the-future-of-libraries>

Rainie, L. (2016). How libraries fit into community education ecosystems. *Pew Research Center: Internet, Science & Tech*. Retrieved from <http://www.pewinternet.org/2016/01/08/how-libraries-fit-into-community-education-ecosystems/>

Rainie, L. (2017). Digital divides: Feeding America. *Pew Research Center: Internet, Science & Tech*. Retrieved from <http://www.pewinternet.org/2017/02/09/digital-divides-feeding-america/>

- Rainie, L., & Anderson, J. (2017, May 3). The future of jobs and jobs training. *Pew Research Center*. Retrieved from <http://www.pewinternet.org/2017/05/03/the-future-of-jobs-and-jobs-training/>
- Recognition of non-formal and informal learning. (2010). OECD. Retrieved from <http://www.oecd.org/education/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm>
- Revisiting the STEM workforce: A companion to science and engineering indicators 2014. (2015). Retrieved from <http://www.nsf.gov/pubs/2015/nsb201510/nsb201510.pdf>
- Richards, L., & Morse, J. (2013). *Readme first for a user's guide to qualitative methods*. Los Angeles, CA: Sage Publications.
- Riel, M. (1994). Educational change in a technology-rich environment. *Journal of Research on Computing in Education*, 26(4), 452-474.  
<http://dx.doi.org/10.1080/08886504.1994.10782103>
- Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2013). *Qualitative research practice*. Los Angeles, CA: Sage Publications.
- Robinson, L., Cotton, S., Ono, H., Quan-Haase, A., Mesch, G., & Chen, W. . . . Stern, M. J. (2015). Digital inequalities and why they matter. *Information, Communication & Society*, 18(5), 569-582. doi:10.1080/1369118x.2015.1012532
- Rosa, K. (Ed.). (2017). *The state of America's libraries 2017: A report from the American Library Association*. Chicago, IL: American Library Association. Retrieved from <http://www.ala.org/news/state-americas-libraries-report-20176>

- Rottenborn, J. (2009). Unstack the odds: Zap the achievement gap so all students can access college—and graduate! Retrieved from [https://issuu.com/mvcap/docs/unstack\\_the\\_odds](https://issuu.com/mvcap/docs/unstack_the_odds)
- Roulston, K., deMarrais, K., & Lewis, J. (2003). Learning to interview in the social sciences. *Qualitative Inquiry*, 9(4), 643-668. doi: 10.1177/1077800403252736
- Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data* (3<sup>rd</sup> ed.). Thousand Oaks, CA: Sage Publications.
- Sanders. M. (2009). STEM, STEM education, STEMmania. *Technology Teacher*, 68(4), 20-26. Retrieved from <https://vtechworks.lib.vt.edu/bitstream/handle/10919/51616/STEMmania.pdf?sequence>.
- Sanders, P. (1982). Phenomenology: A new way of viewing organizational research. *The Academy of Management Review*, 7(3), 353-360. Retrieved from <https://doi.org/10.5465/amr.1982.4285315>
- Santiago, R. (2012). YOUmedia Miami: Engaging youth in powerful new ways. *National Civic Review*, 101(4), 36-38.
- Schwandt, T. (2007). *The SAGE dictionary of qualitative inquiry*. Los Angeles, CA: Sage Publications.
- Schwartz, D. G., Mosher, E., Wilson, S., Lipkus, C., & Collins, R. (2002). Seniors connect: A partnership for training between health care and public libraries. *Medical Reference Services Quarterly*, 21(3), 1-19.
- Science & engineering indicators 2018. (2018). [Report]. National Science Foundation. Retrieved from <https://www.nsf.gov/statistics/2018/nsb20181/report/sections/elementary->

and-secondary-mathematics-and-science-education/student-learning-in-mathematics-and-science

Science, technology, engineering and math: Education for global leadership U. S. Department of Education. (2015). Retrieved from <https://www.ed.gov/stem>

Science, Space, and Technology Committee announces priorities for the 115th Congress.

(2017). Retrieved from <https://science.house.gov/news/press-releases/science-space-and-technology-committee-announces-priorities-115th-congress>

Segura, J. (2017, January 6). Print book sales rose again in 2016. *Publishers Weekly*. Retrieved from <https://www.publishersweekly.com/pw/by-topic/industry-news/bookselling/article/72450-print-book-sales-rose-again-in-2016.html>

Semmel, M. L. (2015). “*Collective impact*” and *STEM Learning: Joining forces to make a difference in communities*. Paper presented at the Public Libraries & STEM Conference, Denver, CO.

Shaping the future of digital economy and society. (n.d.). World Economic Forum. Retrieved from <https://www.weforum.org/system-initiatives/shaping-the-future-of-digital-economy-and-society>

Shatzkin, M. (2011). *The Shatzkin files*. New York, NY: Worthy Shorts.

Shera, J. (1945). The literature of American library history. *The Library Quarterly: Information, Community Policy*, 15(1), 1-24. Retrieved from <http://www.jstor.org/stable/4303297>.

Shilling, R. (2015). STEM programs at the Department of Education: Supporting teachers and students. Retrieved from [https://sites.ed.gov/oii/?guest\\_author\\_name=Russell+Shilling](https://sites.ed.gov/oii/?guest_author_name=Russell+Shilling)

- Space Science Institute, The National Center for Interactive Learning. (2018). STARNET library partnership map. Retrieved from <http://www.starnetlibraries.org/stem-in-libraries/evaluation/>
- Spradley, J. P. (1979). *The ethnographic interview*. Belmont, CA: Wadsworth Group-Thomson Learning.
- STAR Net science-technology activities & resources for libraries. (2018). Retrieved from <https://www.starnetlibraries.org>
- Stark, S. (2013). *Library of the future*. Van Nuys, CA: Greater San Fernando Valley Chamber.
- STEM Education Coalition 2017 annual report. (2018). STEM Education Coalition. Retrieved from <http://www.stemedcoalition.org/wp-content/uploads/2018/03/AR-Test.pdf>
- Stephens, M. (2015). The livelong day. *Library Journal*, 140(17), 50.
- Stern, M., Adams, A., & Elsasser, S. (2009). Digital inequality and place: The effects of technological diffusion on internet proficiency and usage across rural, suburban, and urban counties. *Sociological Inquiry*, 79(4), 391-417. doi:10.1111/j.1475-682x.2009.00302.x
- Subramaniam, M. M., Ahn, J., Fleischmann, K. R., & Druin, A. (2012). Reimagining the role of school libraries in STEM education: Creating hybrid spaces for exploration. *Library Quarterly*, 8(2), 161-182.
- Surdam, D. (2015). *Century of the leisured masses*. New York, NY: Oxford University Press.
- Swan, D., Grimes, J., & Owens, T. (2013). *The state of small and rural libraries in the United States* (Research Brief No. 5). Washington, DC: Institute of Museum and Library Services. Retrieved from [https://www.ims.gov/assets/1/AssetManager/Brief2013\\_05.pdf](https://www.ims.gov/assets/1/AssetManager/Brief2013_05.pdf)

Tanenbaum, C. (2016, September 14). STEM 2026: A vision for innovation in STEM education. *American Institutes for Research*. Retrieved from <https://www.air.org/resource/stem-2026-vision-innovation-stem-education>

Taylor, P., & Keeter, S. (2010, February 24). Millennials: Confident. Connected. Open to change [Executive summary]. *Pew Research Center*. Retrieved from <http://www.pewsocialtrends.org/2010/02/24/millennials-confident-connected-open-to-change/>

Taylor, S., Devault, M., & Bogden, R. (2015). *Introductions to qualitative research methods* (4th ed.). Hoboken, NJ: Wiley. Teens 13–18. (n.d.). American Library Association. Retrieved from [http://www.ala.org/advocacy/advleg/advocacyuniversity/additup/13to18/anntk\\_public](http://www.ala.org/advocacy/advleg/advocacyuniversity/additup/13to18/anntk_public)

The case for investing in out-of-school learning as a core strategy in improving science, technology, engineering, and mathematics (STEM) education. (2016, April). STEM Education Coalition. Retrieved from <http://www.stemedcoalition.org/wp-content/uploads/2016/04/The-Case-for-Informal-STEM-Education-Final-April-2016-1.pdf>

Thompson, J. (2015). Changing needs, changing roles: How public libraries are expanding traditional service models to best serve their communities. *Reference & User Services Quarterly*, 54(3), 2-5. <http://dx.doi.org/10.5860/rusq.54n3.2>.

Thompson, S. (2012). Public libraries: Central to adult learning and literacy. *Australian Public Library and Information Specialist*, 25(4), 190-191. Retrieved from

<https://lib.pepperdine.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=84430356&site=ehost-live&scope=site>

Tierney, W. (2000). Power, identity, and the dilemma of college student departure. In J. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 213-234). Nashville, TN: Vanderbilt University Press.

Toward equality of access: The role of public libraries in addressing the digital divide. (2004). Institute of Museum and Library Services. Retrieved from <https://www.imls.gov/publications/toward-equality-access-role-public-libraries-addressing-digital-divide>

Trochim, W., Donnelly, J. P., & Arora, K. (2015). *Research methods: The essential knowledge base*. Stamford, CT: Cengage Learning.

Tsupros, N., Kohler, R., & Hallinen, J. (2009). *STEM education: A project to identify the missing components*. Pittsburgh, PA: Intermediate Unit 1 and Carnegie Mellon.

Van Maanen, J. (1979). Reclaiming qualitative methods for organizational research: A preface. *Administrative Science Quarterly*, 24(4), 520-26.

Vargas, G. A. T., Vanderkast, E. J. S., García, A. A. R., & González, J. T. G. (2015). The blended librarian and the disruptive technological innovation in the digital world. *Open Access Library Journal*, 2(8), 1.

Vilorio, D. (2014). STEM 101: Intro to tomorrow's jobs. *Occupational Outlook Quarterly*, 58(1), 2.

Visser, M. (2012). Digital literacy definition. *ALA Connect*. Retrieved from <http://connect.ala.org/node/181197>

von Hippel, E. (2017). *Free innovation*. Cambridge, MA: The MIT Press.

- Walters, H., & Bishop, T. (2018). Business and industry support for innovation in STEM education: A case study in ocean science education. Retrieved from <https://greatbluechallenge.org/images/Tennessee-Case-Study.pdf>
- Ward, D. J., & Hart, A. (2008). Economic contribution of Wisconsin public libraries to the economy of Wisconsin. *Wisconsin Department of Public Instruction*. Retrieved from <https://dpi.wi.gov/sites/default/files/imce/pld/pdf/wilibraryimpact.pdf>
- Weinberger, D. (2012). Library as platform. *Library Journal*, 137(18), 34. Retrieved from <http://pepperdine.worldcat.org/oclc/4949019890>
- Wiegand, W. (1999). Tunnel vision and blind spots: What the past tells us about the present: Reflections on the twentieth-century history of American librarianship. *The Library Quarterly*, 69(1), 1-32. doi:10.1086/603022
- White, E. (2018, May 18). State of STEM: Defining the landscape to determine high-impact pathway for the future workforce. *STEMconnector*. Retrieved from <https://www.stemconnector.com/state-stem-report>
- Whyte, L. (n.d.). Andrew Carnegie: Let there be light. *BDS Global Magazine*. Retrieved from <http://www.bdslive.com/article/magazine/andrew-carnegie-article>
- Zickuhr, K., Rainie, L., Purcell, K., & Duggan, M. (2013, December 11). How Americans value public libraries in their communities. *Pew Internet & American Life Project*. Retrieved from <http://libraries.pewinternet.org/2013/12/11/libraries-in-communities/>



## APPENDIX A

### IRB Approval Notice



Pepperdine University  
24255 Pacific Coast Highway  
Malibu, CA 90263  
TEL: 310-506-4000

#### NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: January 22, 2018

Protocol Investigator Name: Cheryl Johnson

Protocol #: 17-10-648

Project Title: Informal Learning Spaces: The Interception of Public Libraries and STEAM

School: Graduate School of Education and Psychology

Dear Cheryl Johnson:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at [community.pepperdine.edu/irb](http://community.pepperdine.edu/irb).

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

## APPENDIX B

### Informed Consent Form

#### PEPPERDINE UNIVERSITY

#### Graduate School of Education and Psychology

### INFORMED CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES

#### **LIBRARIANS LEADING CHANGE: INFORMAL LEARNING SPACES AND THE INTERCEPTION OF PUBLIC LIBRARIES AND STEAM**

You are invited to participate in a research study conducted by Cheryl R. Small, MLS, and Farzin Madjidi, Ed.D. at Pepperdine University, because you are a librarian within a public library organization. Your participation is voluntary. Please read the information below, and ask questions about anything that you do not understand, before deciding whether to participate. Please feel free to take as much time as you need to read the consent form. You are also welcome to discuss participation with your family or friends. If you decide to participate, you will be asked to sign this form. You will also be given a copy of this form for your records.

#### **PURPOSE OF THE STUDY**

The purpose of this research is to explore best practices for the implementation of STEAM programs in a public library system and advancing the informal learning opportunities within public spaces. To accomplish this task, this research will seek and interview librarians who have demonstrated a desire to elevate STEAM programs in public libraries. Through their interviews, this research will discern the best practices employed by them that contribute to success. In addition, this research aims to identify challenges and obstacles that librarians face in leading effective implementation. Most importantly, this research will look beyond the obstacles and challenges and identify the strategies that better help maneuver the difficulties that sometimes stifles success in public libraries. Ultimately, this research will provide a model of success that other librarians can employ to help them lead an implementation that delivers effective and efficient informal learning opportunities for its users.

#### **STUDY PROCEDURES**

If you volunteer to participate in this study, you will be asked to:

1. Review the provided interview questions.
2. Review the informed consent form.
3. Answer the 4 qualitative interview questions.
4. Review and approve your responses to the interview questions after your responses have been transcribed.

#### **POTENTIAL RISKS AND DISCOMFORTS**

The potential and foreseeable risk associated with participation in this study include no more than minimal risk. Possible risks for participating in the study include, but are not limited to:

1. potential breach of confidentiality
2. potential risk to reputation
3. self-efficacy; boredom; fatigue; and negative self-reflection.

### **POTENTIAL BENEFITS TO PARTICIPANTS AND TO SOCIETY**

While there are no direct benefits to the study participants as this is a qualitative study, your responses will be used as data for a doctoral dissertation focusing on identifying leadership

best-practices of librarians in the implementation of informal learning opportunities in science, technology, engineering, arts, and math (STEAM). Additionally, this information will help in educating future librarians in the best practices in the effective implementation of STEAM initiatives in public libraries.

### **CONFIDENTIALITY**

I will keep your records for this study confidential as far as permitted by law. However, if I am required to do by law, I may be required to disclose information collected about you. Examples of the types of issues that would require me to break confidentiality are if you tell me about instances of child abuse and elder abuse. Pepperdine University's Human Subjects Protection Program (HSPP) may also access the data collected. The HSPP occasionally reviews and monitors research studies to protect the rights and welfare of research subjects.

The data was stored on a password-protected computer in the principal investigator's place of residence. The data will be stored for a minimum of three years. The data collected will be transcribed and coded by for validity and reliability purposes. Upon an initial coding taking place, the data will then be provided to two carefully selected doctoral peer reviewers with a similar amount of training and preparation for conducting qualitative research. They will also code the information based on what they hear from the audio interview. Their coding will be used as a comparison to the researcher to ensure the accuracy of what is interpreted from your provided commentary. Upon conducting the data gathering, this information will be provided to the principal investigator, and any evidence deleted from their computers. You will then be provided a copy of the transcribed notes and coding to verify the information determined from the recordings. Upon your approval, this information will be used all or in part of the finding section of the dissertation.

### **PARTICIPATION AND WITHDRAWAL**

Your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw your consent at any times and discontinue participation without penalty. You are not waiving and legal claims, rights or remedies because of your participation in this research

### **ALTERNATIVES TO FULL PARTICIPATION**

The alternative to participation in the study is not participating or completing only the items which you feel comfortable.

### **EMERGENCY CARE AND COMPENSATION FOR INJURY**

If you are injured as a direct result of research procedures you will receive medical treatment. However, you or your insurance will be responsible for the cost. Pepperdine University does not provide any monetary compensation for injury.

### **INVESTIGATOR'S CONTACT INFORMATION**

I understand that the investigator is willing to answer any inquiries I may have concerning the research herein described. I understand that I may contact Dr. Farzin Madjidi if I have any other questions or concerns about the research.

### **RIGHTS OR RESEARCH PARTICIPATION – IRB CONTACT INFORMATION**

If you have questions, concerns or complaints about your rights as a research participant or research, in general, please contact Dr. Judy Ho, Chairperson of the Graduate & professional Schools Institutional Review Board at Pepperdine University 6100 Center Drive, Suite 500, Los Angeles, CA 90045, 310-568-5753 or gpsirb@pepperdine.edu.

### **RIGHTS OF RESEARCH PARTICIPANTS - IRB CONTRACT INFORMATION**

If you have questions, concerns or complaints about your rights as a research participant or research in general please contact Dr. Judy Ho, Chairperson of the Graduate & Professional Schools Institutional Review Board at Pepperdine university 6100 Center Drive Suite 500 Los Angeles, CA 90045, 310-568-5753.

### **SIGNATURE OF RESEARCH PARTICIPANT**

I have read the information provided above, I have been given a chance to ask questions. My questions have been answered to my satisfaction and I agree to participation in this study. I have been given a copy of this form.

### **AUDIO**

\_\_\_\_\_ I agree to be audio or video recorded.

\_\_\_\_\_ I do not want to be audio or video recorded.

\_\_\_\_\_  
Name of Participant

\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Date

## APPENDIX C

### Interview Recruitment E-mail Script

Good morning.

My name is Cheryl Small, and I am a doctoral student in the Graduate School of Education and Psychology at Pepperdine University. I am conducting a research study examining the phenomena of informal learning in the form of STEAM in public libraries and you are invited to participate. If you agree, you are invited to participate in an interview using ZOOM, A Video and Audio Conferencing software between February January 15–31, 2018. The interview is anticipated to take no more than one hour to complete. With your permission, I would also like to audio record our conversation in order to review it as necessary to complete my research. Your identity as a participant will remain confidential during and after the study. To protect confidentiality, I will secure a private space to interview, I will not publish the interview schedule, and use numbers instead of names on all securely stored notes and audio files associated with your interview.

Are you interested in participating in this study? If you would be willing to be interviewed as part of this study, let me know what your availability might be during the week(s) of January 15–31, 2018.

If yes, thank you for your participation. I will follow up immediately via e-mail to provide detailed information about the nature of the study and include a copy of interview questions. If at any time you decide you do not wish to participate in the study, you only need to let me know.

Thank you for your participation,

Cheryl R. Small  
Doctoral Candidate  
Graduate School of Education and Psychology  
Pepperdine University  
Cheryl.small@pepperdine.edu  
770-906-5989

Dr. Farzin Madjidi  
Dissertation Chair  
Associate Dean, Graduate School of Education and Psychology  
Pepperdine University  
farzin.madjidi@pepperdine.edu

## APPENDIX D

### Interview Recruitment Phone Script

Good morning/Good afternoon [potential participant name],

My name is Cheryl Small, and I am a doctoral student in the Graduate School of Education and Psychology at Pepperdine University. I am conducting a research study examining the phenomena of informal learning in the form of STEAM in public libraries and you are invited to participate. If you agree, you are invited to participate in an interview using ZOOM, A Video and Audio Conferencing software between January 15–31, 2018.

The interview is anticipated to take no more than one hour to complete. With your permission, I would also like to audio record our conversation in order to review it as necessary to complete my research. Your identity as a participant will remain confidential during and after the study. To protect confidentiality, I will secure a private space to interview, I will not publish the interview schedule, and use numbers instead of names on all securely stored notes and audio files associated with your interview.

Are you interested in participating in this study? If you would be willing to be interviewed as part of this study, let me know what your availability might be during the week(s) of January 15-31, 2018

If so, I will follow up immediately via e-mail to provide detailed information about the nature of the study and include a copy of interview questions, If at this time, you decide you do not wish to participate in the study, you only need to let me know. Please let me know if I may I continue utilizing this e-mail address or do you have another e-mail address you are more comfortable with me sending this information to?

Thank you for your participation,

Cheryl R. Small  
Pepperdine University  
Graduate School of Education and Psychology  
Status: Doctoral Student

## APPENDIX E

### Interview Questions Process Form

**Participant Pseudonym:** \_\_\_\_\_

**Librarian:** \_\_\_\_\_ **Gender: M/F** \_\_\_\_\_

**Length of tenure in current role:** \_\_\_\_\_

**Highest level of education** \_\_\_\_\_

**Anticipated expansion of current STEAM program** \_\_\_\_\_

**Interview Question 1:** What were your strategies for creating and implementing STEAM programs?

Notes:

Follow up question(s)

- How did you decide on the structure of your STEAM program?
- How do you define a STEAM program in your library?

**Interview Question 2:** What challenges did you face in the planning phase of the implementation?

Notes:

Follow up question(s)

- Planning
- Design
- Implementation
- post implementation

**Interview Question 3:** How did you deal with or overcome the challenge in:

- planning
- design
- implementation
- post implementation

Notes:

Follow up question(s)

**Interview Question 4:** How did you overcome resistance or opposition to your plan?

Notes:

Follow up question(s):

**Interview Question 5:** How did you define success for the STEAM implementation?

Notes:

Follow up question(s):

**Interview Question 6:** How did you measure and track your success?

Notes:

Follow up question(s):

**Interview Question 7:** What recommendations would you make for public libraries in the implementation process?

Notes:

Follow up question(s):

**Interview Question 8:** If you could start over, what would you do differently

Notes:

Follow up Questions(s):

**Interview Question 9:** Is there anything else you would like to share?

Notes:

Follow up Questions(s):



## APPENDIX F

### Peer Reviewer Form

Dear reviewer:

Thank you for agreeing to participate in my research study. The table below is designed to ensure that may research questions for the study are properly addressed with corresponding interview questions.

In the table below, please review each research question and the corresponding interview questions. For each interview question, consider how well the interview question addresses the research question. If the interview question is directly relevant to the research question, please mark “Keep as stated.” If the interview question is irrelevant to the research question, please mark “Delete it.” Finally, if the interview question can be modified to best fit with the research question, please suggest your modifications in the space provided. You may also recommend additional interview questions you deem necessary.

Research Question	Corresponding Interview Question
RQ 1: What strategies and practices have been implemented in public libraries to promote informal learning opportunities related to STEAM?	<p>What were your strategies for creating and implementing STEAM programs?</p> <ul style="list-style-type: none"> <li>• How did you decide on the structure of your STEAM program?</li> <li>• How do you define a STEAM program in your library?</li> </ul> <p>a. The question is directly relevant to Research question - <b>Keep as stated</b>  b. The question is irrelevant to research question – <b>Delete it</b>  c. The question should be <b>modified as suggested</b>:</p> <p>_____</p> <p>_____</p> <p>I recommend adding the following interview questions:</p> <p>_____</p> <p>_____</p> <p>_____</p>

(continued)


Research Question	Corresponding Interview Question
RQ 2: What are the challenges that public libraries face as it relates to the promotion of informal learning programs focused on STEAM?	<p>IQ 2: What challenges did you face in the planning phase of the implementation?</p> <ul style="list-style-type: none"> <li>● Planning</li> <li>● Design</li> <li>● Implementation</li> <li>● post implementation</li> </ul> <p>IQ 3: How did you deal with or overcome the challenge in:</p> <ul style="list-style-type: none"> <li>● Planning</li> <li>● Design</li> <li>● Implementation</li> <li>● Post implementation</li> </ul> <p>IQ 4: How did you overcome resistance or opposition to your plan?</p> <p>a. The question is directly relevant to Research question - <b>Keep as stated</b></p> <p>b. The question is irrelevant to research question—<b>Delete it</b></p> <p>c. The question should be <b>modified as suggested</b>:</p> <hr/> <hr/> <p>I recommend adding the following interview questions:</p> <hr/> <hr/> <hr/>

(continued)

Research Question	Corresponding Interview Question
RQ 3: How do public libraries measure success in the promotion of informal learning programs related to STEAM?	<p>IQ 5: How did you define success for the STEAM implementation?</p> <p>IQ 6: How did you measure and track your success?</p> <p>a. The question is directly relevant to Research question - <b>Keep as stated</b></p> <p>b. The question is irrelevant to research question – <b>Delete it</b></p> <p>c. The question should be <b>modified as suggested</b>:</p> <hr/> <hr/> <p>I recommend adding the following interview questions:</p> <hr/> <hr/> <hr/>
RQ 4: Are there any lessons learned in the promotion of informal learning spaces focused on STEAM in the public library?	<p>IQ 7: What recommendations would you make for public libraries in the implementation process?</p> <p>IQ 8: If you could start over, what would you do differently?</p> <p>IQ 9: Is there anything else you would like to share?</p> <p>a. The question is directly relevant to Research question - <b>Keep as stated</b></p> <p>b. The question is irrelevant to research question – <b>Delete it</b></p> <p>c. The question should be <b>modified as suggested</b>:</p> <hr/> <hr/> <p>I recommend adding the following interview questions:</p> <hr/> <hr/> <hr/>


## APPENDIX G


### Permissions for Use of Diagrams

**Cheryl Small 'student'** <cheryl.small@pepperdine.edu>  
to aholland


Oct 19 (2 days ago)

Dear Ms.Holland,  
  
My name is Cheryl Small and currently a student at Pepperdine University and would like permission to use the "Library Partnership Map" from the Starnet website in a research project. Please inform of any other needed information as well as any particulars related to the use of the chart as mentioned earlier.  
  
Regards,  
  
Cheryl R. Small  
Doctoral Student  
Pepperdine University  
Graduate School of Education and Psychology  
EDD in Organizational Leadership  
Tel: [770-906-5989](tel:770-906-5989) Email: [Cheryl.small@pepperdine.edu](mailto:Cheryl.small@pepperdine.edu)



**Anne Holland**  
aholland@spacescie...


Show details


**Anne Holland**

2:17 PM (10 hours ago)


to Greg, me

Hi Cheryl!! Absolutely! I'm glad it will be helpful for you. Greg (copied) will also send you a flyer with some statistics you may be interested in.  
  
Anne



**Anne Holland**  
aholland@spacescie...

Show details

**Anne Holland**

2:17 PM (10 hours ago)

to Greg, me

Hi Cheryl!! Absolutely! I'm glad it will be helpful for you. Greg (copied) will also send you a flyer with some statistics you may be interested in.  
  
Anne  
  
Anne Holland  
Community Engagement Manager  
Space Science Institute  
National Center for Interactive Learning  
  
[4750 Walnut Street](#)  
[Suite 205](#)  
[Boulder, CO 80301](#)  
  
Work [720-974-5876](tel:720-974-5876)  
Cell [808-938-9328](tel:808-938-9328)  
[www.spacescience.org](http://www.spacescience.org)  
ormal">

(continued)

Cheryl Small 'student' <cheryl.small@pepperdine.edu>  
to info

Oct 1

Pew Research Center  
info@pewresearch.org

Dear Pew Research Center,

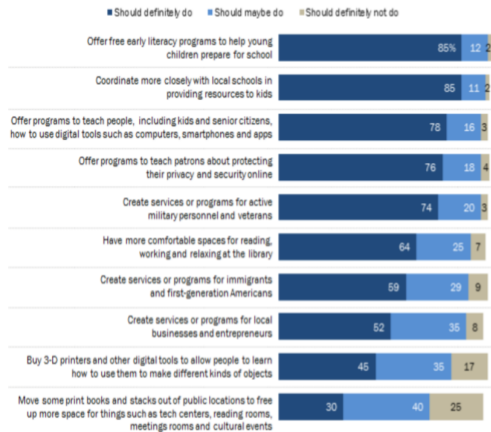
My name is Cheryl Small and currently a student at Pepperdine University and would like permission to use the diagrams below in a research project. Please inform of any other needed information as well as any particulars related to the use of the aforementioned diagram.



Show details

Public Wants Libraries to Advance Education, Improve Digital Literacy and Serve Key Groups

% of those ages 16+ who say that libraries should definitely, maybe or definitely not do these things



Source: Pew Research Center survey March 17-April 12, 2015. N=2,004 Americans ages 16 and older  
PEW RESEARCH CENTER

Pew Research Center  
to me

Oct 2

Hi Cheryl,  
Thanks for reaching out. As this is for academic purposes, you do not need express permission to use our data or graphics.

Best,  
Leila Barzegar  
Pew Research Center